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The genus Calymperes in the Americas *William D. Reese* 89
A revision of the genus Rhabdoweisia *Elva Lawton* 140
The genera Thysananthus, Ptychocoleus, Tuzibeanthus, Phragmilejeunea, and Brachiolejeunea (Lejeuneaceae Holostipae) *Rudolf M. Schuster* 156
Studies on lichenized fungi *Vernon Ahmadjian* 168
Bryophytes collected during the Arctic Field Trip of the Ninth International Botanical Congress *Herman Persson and Kjeld Holmen* 179
Studies on Hepaticae. III-VI. *Rudolf M. Schuster* 198
Notes on North American Sphagnum. XIII. Sphagnum pylaesii *A. LeRoy Andrews* 208
Studies on the mosses of Luray Cavern *Paul V. Prior* 215
A checklist of the mosses of the state of Arizona *Inez M. Haring* 222
Lichens of northern Saskatchewan *John W. Thomson and George W. Scotter* 240
Bryophytes of the Galápagos Islands collected principally by Gunnar Harling in 1959 *E. B. Bartram and S. Arnell* 248
Validity of Riccia media *K. R. Bapna* 250
The 1960 foray of the American Bryological Society in Oklahoma *John W. Thomson* 252
Lichens collected in Oklahoma at the time of the American Bryological Society meetings *John W. Thomson* 255
The discovery of Merceya in Illinois *G. Neville Jones* 263
Bryophytes of southwest Missouri. IV. Additions to the flora *Paul L. Redfearn, Jr.* 266
Reviews 267
Recent literature 269
News and Notes 286

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THE BRYOLOGIST

JOURNAL OF

THE AMERICAN BRYOLOGICAL SOCIETY

VOLUME 64 SUMMER–AUTUMN NUMBERS 2 AND 3

THE GENUS CALYMPERES IN THE AMERICAS

WILLIAM D. REESE[1]

This study is a taxonomic revision of the species of *Calymperes*, a genus of mosses of the family Calymperaceae, which occur in the tropical and subtropical regions of North and South America. The work for this study was done over a period of several years, partly at Florida State University, Tallahassee, and the remainder at the author's present address.[2] A revision of the North American species was completed first, and it was originally planned to publish this separately, in advance of the revision of the South American species. Various delays intervened, however, perhaps fortunately so, with the result that the revisions for the two areas, although done separately, can be combined and presented as a unit.

Thanks are owing to a number of individuals who have given generously of their time and have helped in various other ways during the course of this study. I wish to single out the following for especial thanks: Prof. RUTH S. BREEN, my advisor at Florida State University; Dr. A. L. ANDREWS, who lent the unpublished drawings of the Calymperaceae by G. Roth; Dr. W. C. STEERE, who generously made available his unpublished notes and other materials concerning the genus *Calymperes*; Dr. H. A. CRUM, who helped with certain problems in nomenclature and bibliography. I also wish to thank the following individuals and the herbaria from whom the materials for this study were borrowed:

E. B. Bartram; W. C. Steere; T. Herzog; Botanical Dept., University of Helsinki; Botanische Staatssammlung, München; British Museum (Natural History), London; Chicago Natural History Museum; Conservatoire et

[1] Dept. of Biology, University of Southwestern Louisiana, Lafayette.

[2] The work at Tallahassee was supported by two consecutive predoctoral fellowships from the National Science Foundation and represents part of a doctoral dissertation completed in the Dept. of Biological Sciences, Florida State University, in August 1957. The portion of the work done at the University of Southwestern Louisiana was supported by a grant (G-5629) from the National Science Foundation, to which grateful acknowledgment is made.

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Herbaria, from which specimens cited in the text were borrowed are identified according to the *Index Herbariorum* (ed. 4), with the exception of the private herbaria of Bartram and Steere. These are identified as BART and STER, respectively.

The name *Calymperes* was first published by Olof Swartz (1813), with a short description but no mention of species. The genus was redescribed by Schwaegrichen (1816), who included descriptions of two species. One of these, *C. lonchophyllum*, described from "*Gujana*" (Guiana) is the type species of the genus and the first to be reported from the Americas. The next species to be described from the Americas was *C. guildingii*, described by Hooker and Greville (1825) from the island of St. Vincent. C. Müller (1849-51) included six species from the Americas, four of which were described by him. Two of these four, *C. richardii* and *C. erosum*, are still valid species. In addition Müller created two sections within the genus, HYOPHILINA and EUCALYMPERES. Mitten (1869) reported nine species of *Calymperes* for the Americas. Only five of these, including his new species, *C. platyloma*, are still valid. Following Mitten's work various authors described a number of new species, and Bescherelle (1895), in his world-wide monographic treatment of the genus, was able to report a total of 25 species for the Americas. Unfortunately Bescherelle, in spite of his great capacity for work, was not a very discriminating taxonomist, and as a result only one of the 11 new species he described from the Americas, *C. levyanum*, has proved to be well founded. Bescherelle also restored Müller's section EUCALYMPERES, which Mitten (1868) had replaced with his own section HIMANTOPHYLLUM, and created five new subsections. The fact that Bescherelle classified a single species, *C. richardii*, under six different names distributed among three subsections serves to illustrate not only his lack of taxonomic acuity at the specific level, but also the artificial nature of some of his subsections. Brotherus (1901), in the first edition of *Die natürlichen Pflanzenfamilien*, raised the sections of Müller to the rank of subgenera, and the subsections of Bescherelle to the rank of sections. He noted that his treatment of the genus was taken almost unchanged from that of Bescherelle. In Roth's review of the genus (1912), a third

subgenus, SOMPHONEURUM, was created. Roth was apparently almost entirely uncritical and accepted nearly without question the numerous, mostly ill-founded species of, principally, Paris and Brotherus and C. Müller, which had appeared in a deluge after Bescherelle's revision. Roth's laboriously prepared drawings of the Calymperaceae, which are quite useful since they were taken in many cases from the type specimens, were never published. They are in the possession of Dr. A. L. Andrews. Williams (1920) published a revision of the North American (Florida, Mexico, Central America, and Caribbean) species of the Calymperaceae which included 12 species of *Calymperes*. Three of these were described as new. In this revision Williams performed a great service by properly making synonyms of a number of names which were causing confusion in the taxonomy of the genus. Brotherus' treatment of the genus in the second edition of *Die natürlichen Pflanzenfamilien* (1924), the most recent comprehensive review, included no major changes.

During the course of this revision over 50 names which had been applied to American *Calymperes* were accumulated. A number of these eventually proved to be reducible to synonyms, while others turned out to be *nomina nuda*, or manuscript or herbarium names without taxonomic status. Still others were excluded from *Calymperes* because they represented species of other genera. From all the specimens examined there finally emerged a total of 16 distinct species, including two previously undescribed.

The greatest concentration of *Calymperes* in the Americas is found in northern South America where 13 species occur, five of which do not occur elsewhere. Three of these five species are known only from a single collection, and the other two are known from two collections each. Three species occur only in South America and the Caribbean; none is restricted to South America and Central America. A single species is restricted to the Caribbean and Central America, while one other is apparently endemic to Central America. All four species which have been found in Florida also occur in the Caribbean. Three of these have a general distribution throughout the Americas; the fourth is restricted to Florida and the northern Caribbean. Of all 16 species only three have a continuous distribution throughout the entire area. Northern South America is obviously the center of distribution for the genus in the New World, with dispersal to the north proceeding, for the most part, across the Antilles to Central America and Florida. It is, of course, not possible in the case of some of the ubiquitous species to state with certainty the path of migration; but the evidence indicated by the distributional pattern of the three species

which occur in South America and the Caribbean Islands but not elsewhere seems pretty clear. Everything points to the Antilles, rather than to the Isthmus of Panama, as the major dispersal route to the north. Bartram (1929), Crum (1952), and Crum and Steere (1958) are among those who have commented on distributional patterns of bryophytes in the area between continental North and South America.

One fact has become apparent during the course of this work, and that is the need for a great deal more collecting in northern South America. Large areas of Venezuela, Colombia, extreme northern Brazil, and the Guianas, are virtually unexplored bryologically, and this is a region of critical importance for many genera of mosses other than *Calymperes*. It is certain that a wealth of new species and phytogeographical information awaits reporting from this vast region.

Observations from which the descriptions of the species were drawn were made from specimens mounted in Hoyer's Solution, as described by Anderson (1954).

CALYMPERES Sw. *in* Web., Tab. Calyptr. Oper. Musc. Frond. Gen. 2. 1813. Plants dioicous, mostly small to medium in size, usually 3-30 mm. tall, green to dark green, occasionally blackish, mostly corticolous, occurring throughout the tropical and subtropical regions of the world mainly in the lowlands but with some species represented at altitudes of well over 1000 m. In the Americas the genus reaches its northern limit in Florida and southern Mexico and its southern limit in Bolivia and southern Brazil.

The genus is characterized by the persistent, perforated calyptra which entirely encloses the capsule and clasps the seta below, by the absence of a peristome, and by the presence of certain unique structures, the teniolae, in the leaves of the majority of the species. In addition, *Calymperes* shares with several related genera other distinctive leaf structures, the cancellinae. A character of less significance is the production of septate propagula at or near the apices of the more or less modified upper leaves.

The leaves are mostly involute and variously incurved and contorted when dry, or ascending and widely spreading when moist. A leaf consists of the upper lamina composed of small green cells and the lower lamina containing the cancellinae. The propaguliferous leaves (*folia anomala* or *folia proboscidea* of earlier authors) are usually produced at the upper end of the plant and are often quite different from the leaves which do not bear propagula. In some propaguliferous leaves in which the costa is enlarged and excurrent, the upper lamina is greatly reduced and may occupy only

a small area in the angles between the apices of the cancellinae and the costa. In other leaves the upper lamina is constricted above the middle and represented by only a few rows of cells along either side of the greatly enlarged costa, or in others constricted above and revolute around the costa for a portion of its length and then slightly expanded again at the apex. The non-propaguliferous leaves of most species are more or less ligulate to subulate or oblong-lanceolate from the sheathing or clasping lower lamina which is almost entirely filled by the enlarged, thin-walled, hyaline cells of the cancellinae. These latter structures are sharply separated from the small, green cells of the upper lamina. The teniolae consist of one or more rows of thick-walled, narrowly elongated cells lying within the leaf margins and may extend from the base of the leaf to near the apex or may be confined to the upper part of the lower lamina. The teniolae gradually disappear in the lower part of the leaf, while in the upper part they appear to become incorporated into the usually thickened leaf margin, where they appear in cross-section, in many species, as stereid cells. In species in which the teniolae are short and confined to the upper part of the lower lamina, they appear as downward, intramarginal extensions of the leaf border. Even in some of the species which typically lack teniolae, such as *C. nashii*, some collections show traces of them in the intramarginal area near the apex of the cancellinae. The leaf cells range from smooth to papillose or highly mammillose and vary in shape from transversely elongated to square, round, or vertically elongated. The leaves in cross-section consist of a usually large costa containing one or more central rows of guide cells, with bands of stereid cells above and below (except in *C. uleanum* and occasional specimens of *C. richardii*). Accessory guide cells occur in some species. Between the costa and the leaf border the lamina is unistratose (except in *C. lonchophyllum* and *C. venezuelanum*, where it may be irregularly bistratose above). The leaf border in cross-section may be round, triangular, square, or rectangular, and at least in the upper part of the leaf is always more than one cell-layer thick, usually consisting of several layers of thick-walled cells which may enclose one or a few stereids at the center. The leaf margin may be entire or variously toothed. Most species bear clavate or filiform propagula at or near the leaf apices and usually on the ventral surface of the costa.

Most species produce sporophytes infrequently; some have not yet been found with capsules. Vegetative propagation, by means of the abundant propagula, appears to be the most significant form of reproduction for many of the species.

The persistent, plicate calyptra, which is often roughened above,

bears several vertical fissures a short distance below the apex; through these the spores escape from the enclosed capsule. At the base of the capsule the calyptra is constricted and spirally twisted so that it clasps the seta firmly. The operculum is usually clamped by its beak inside the apical part of the calyptra and held well away from the mouth of the capsule when dry. In soaked sporophytes the operculum and the capsule swell together and close the mouth of the capsule. The capsule is cylindrical and erect, usually without a definite neck and, in all but a few species, bears several stomata at the base. The seta is smooth below, often slightly roughened above, and generally short (3-10 mm. long). The perichaetial leaves are shorter and with cancellinae less sharply defined than in the stem leaves. Since sporophytes are very similar throughout the genus, only one has been illustrated, that of *C. nicaraguense*.

Antheridia are formed terminally in abundant tight clusters surrounded by much reduced leaves on very short, lateral branches, which are usually hidden by the sheathing bases of the stem leaves. The archegonia are sparse and are borne terminally on the main stem and on the one or more innovations arising just below the archegonial site of the previous season.

The American species of *Calymperes* segregate very naturally into the three established subgenera (CALYMPERES, HYOPHILINA, SOMPHONEURUM), but the classification of the species into sections within one of the subgenera, HYOPHILINA, is not at all satisfactory. This situation results from the attempt by Bescherelle, who originally established the sections (as subsections), to circumscribe them solely on the basis of the shape and position of the cancellinae. That this attempt was not altogether successful, owing to the variable nature of the cancellinae, is amply attested to by the fact, mentioned earlier, that *C. richardii* was classified by Bescherelle under six names distributed among all three sections of HYOPHILINA. Furthermore, the situation has not improved since Bescherelle's time inasmuch as later reviewers of the genus (Brotherus and Roth) have adhered to Bescherelle's concept of the sections and have distributed additional synonyms of *C. richardii*, as well as of other species, variously among the sections. In view of the fact that confusion exists as to the most natural classification of the species below the subgeneric level, a confusion which cannot be cleared up until the genus is dealt with on a world-wide basis, I have thought it best not to attempt the classification of the American species below the subgeneric level, and have merely indicated the disposition of the species into the subgenera.

1. Leaf cells transversely elongated; upper lamina linear.....2
1. Leaf cells not transversely elongated; upper lamina not linear.....4

2. Leaves papillose dorsally and ventrally in the upper portion ..... 2. *C. levyanum*
2. Leaves not papillose 3

3. Lamina continuous from cancellinae to apex ..... 1. *C. lonchophyllum*
3. Lamina interrupted for an interval of 2-3 mm. above the cancellinae ..... 3. *C. venezuelanum*

4. Teniolae mostly absent, occasionally represented by traces; cancellinae narrow, small; plants usually minute, 2-3 mm. tall 5
4. Teniolae mostly present, marginal or intramarginal, if absent then plants much more than 3 mm. tall; cancellinae various, mostly broad 6

5. Cells at midleaf square, thin-walled, 6-8 μ in diameter; margin of upper lamina entire, bistratose ..... 5. *C. nashii*
5. Cells at midleaf rounded or nearly square, thick-walled, ca. 13 μ in diameter; margin of upper lamina crenulate, unistratose ..... 6. *C. rufum*

6. Teniolae marginal, at least below the leaf shoulders, if intramarginal above the shoulders then becoming very broad below 7
6. Teniolae intramarginal 11

7. Teniolae narrow at the leaf shoulders, 2-6 cells wide 8
7. Teniolae very broad at and below the leaf shoulders, up to 16 cells wide 9

8. Cancellinae extending above the shoulders; cells at midleaf ca. 5 μ in diameter, minutely papillose dorsally ..... 10. *C. meyeri*
8. Cancellinae terminating well below the shoulders; cells at midleaf ca. 8 μ in diameter, bulging dorsally ..... 11. *C. smithii*

9. Upper lamina strongly involute when moist, margins infolded ..... 16. *C. bartramii*
9. Upper lamina plane or channeled when moist, not involute, margins plane 10

10. Cells at midleaf smooth, slightly bulging dorsally; costa ca. 100-115 μ wide at the apex of the cancellinae ..... 9. *C. lanceolatum*
10. Cells at midleaf papillose dorsally; costa ca. 75-85 μ wide at the apex of the cancellinae ..... 8. *C. platyloma*

11. Leaf cells smooth or slightly bulging-mammillose ventrally; upper lamina often as broad or broader than the lower; cancellinae forming very broad angles above with the costa ..... 7. *C. richardii*
11. Leaf cells papillose or highly mammillose ventrally, at least in the upper part of the leaf; upper lamina usually narrower than the lower; cancellinae usually forming acute angles above the costa 12

12. Teniolae extending to or above midleaf, always present and well developed; upper lamina of non-propaguliferous leaves broadly lanceolate 13

12. Teniolae confined to the basal part of the leaf, occasionally reduced or absent; upper lamina subulate or narrowly lanceolate 15

13. Leaf cells mostly 4-6 μ in diameter; apical cells of the cancellinae smooth ventrally..... 12. *C. donnellii*
13. Leaf cells mostly 6-10 μ in diameter; apical cells of the cancellinae highly mammillose ventrally..... 14

14. Cancellinae acute at the apex or irregularly rounded; costa smooth dorsally below the apex of the cancellinae, in cross-section with well-defined bands of stereid cells..... 13. *C. erosum*
14. Cancellinae broadly and evenly rounded at the apex; costa papillose dorsally below the apex of the cancellinae, in cross-section without well-defined bands of stereid cells..... 4 *C. uleanum*

15. Leaf margins above the cancellinae perfectly smooth except for a few distant teeth; cells of the teniolae at the leaf shoulders sinuate, pitted, with irregularly thickened walls; basal margins often entire; teniolae uniformly present..... 15. *C. guildingii*
15. Leaf margins above the cancellinae usually minutely serrulate, often slightly winged; cells of the teniolae at the leaf shoulders not as above; basal margins uniformly serrate; teniolae sometimes reduced or absent..... 14. *C. nicaraguense*

Subg. *Eucalymperes* (C. M.) Broth. *in* E. & P., Nat. Pfl. 1(3): 378. 1901. *Eucalymperes* C. M., Syn. 1: 526. 1849 (as a *sectio*). Leaves long-linear (in the American species), the upper lamina much more than three times the length of the lower. Three species are known from the Americas.

1. C. LONCHOPHYLLUM Schwaegr., Suppl. Sp. Musc. 1: 333. 1816. *C. asperipes* Besch., Ann. Sci. Nat. 8, 1: 277. 1895. *C. lonchophylloides* C. M., Gen. Musc. Fr. 362. 1900. Plants olive-green or lighter in the herbarium, up to 24 mm. long; leaves straight in the lower one-third when dry and the upper two-thirds variously contorted, twisted, or coiled, mostly plane and erect or secund when wet, 8-14(-20) mm. long, mostly 0.3-0.4 mm. wide at midleaf; upper lamina narrowly linear from the oblong or oval base, sometimes abruptly constricted above the shoulders; lower lamina about 1-1.5 mm. long, only slightly broader than the upper, persistently folded and usually only slightly sheathing; propagula papillose-roughened, filiform-clavate, ca. 230 μ long, arising in clusters from the ventral surface of the leaf apex and occasionally occurring singly along the ventral surface of the costa in the upper half of the leaf; rhizoids occasionally formed together with the propagula at the leaf apex; cancellinae mostly rounded above,

consisting of ca. 6-10 rows of rectangular, square, or circular cells which almost fill the leaf base; costa ending a few cells below the leaf apex or percurrent, 70-150 μ wide at the apex of the cancellinae, smooth on the dorsal and ventral surfaces, the cross-section with 1-3 median rows of guide cells and with thick bands of stereid cells above and below the guide cells, the outer cells differentiated dorsally and ventrally; leaf cells often in 2 layers in scattered areas of the upper lamina or sometimes the entire upper lamina bistratose, the cells at midleaf varying greatly in size and shape, at least some, usually most of them, transversely elongated; cell walls considerably thickened, the lumina, in outline, circular, oval or oblong; transversely elongated cells mostly ca. 5 × 9 μ, smooth on dorsal and ventral surfaces; teniolae absent in stem leaves, occasionally present in the perichaetial leaves; leaf margins much thickened, triangular in cross-section and ± distantly toothed and winged above on the angles, the teeth usually in pairs, one on the dorsal and one on the ventral angle; margins entire or nearly so below midleaf and entire to strongly serrate along the lower lamina and at the shoulders, strongly toothed at the apex, the cross-section composed solely of large cells, or with a few stereids; perichaetial leaves shorter than the stem leaves, the bases more sheathing and with the margins more strongly and irregularly serrate, the cancellinae less distinctly demarcated from the upper lamina. Capsule 1.7-2.5 mm. long, with a few stomata at the base, cylindric; operculum rostrate, ca. 1.1 mm. long, the beak arising from a flattened-conic base; spores 17-24 μ in diameter, finely papillose; calyptra 4-4.7 mm. long, more or less papillose-roughened above; seta ca. 10 mm. long, straight or flexuous. *Fig.* 1-6.)

TYPE: *Richard,* in arboribus guyanne (PC). The type specimen bears on the cover, in addition to the above information, the name *"Calymperis lonkophyllum"* and "No. 38." The word "type" and a citation of the original place of publication have been written on the cover. Schwaegrichen's reference to the specimen in the original description is as follows: *"In arboribus Gujanae legit clar. Richard."*

C. lonchophyllum is a common and widely distributed species that is easily recognized by its very long and narrow leaves. In *C. levyanum* the upper cells of the leaves are densely papillose, and in *C. venezuelanum* there is an interval of bare costa above the shoulders. Although various authors have reported that teniolae are present in the leaves of *C. lonchophyllum,* I have not been able to find them in the stem leaves of any of the collections examined. Good teniolae have been found, however, in the perichaetial leaves of a few collections.

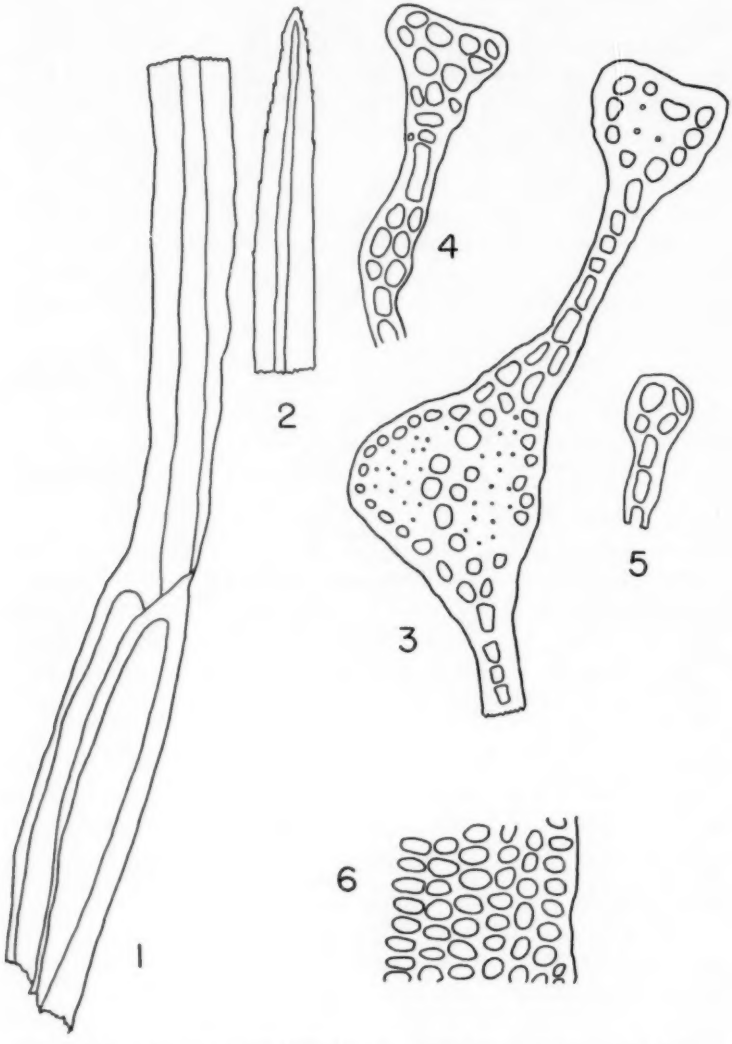

FIG. 1-6. *Calymperes lonchophyllum*. 1. Leaf base, × 23. 2. Leaf apex, × 23. 3. Cross-section of leaf, × 380. 4-5. Cross-sections of leaf margin, × 380. 6. Margin and cells at midleaf, × 380. (Fig. 1, 2, and 4, from *W. E. Broadway* 7843, Trinidad. Fig. 3 and 6 from *M. & H. Stehle* 3972, Martinique. Fig. 5 from *J. A. Steyermark* 4465, Guatemala.)

The type specimen of *C. asperipes* Besch. (GUADELOUPE: *Ed. Marie* 300, NY) has been examined and found not to differ in any significant way from typical *C. lonchophyllum*. The name *C. lonchophylloides* was published by Müller without a description save for the expression "*kurz-stengelige*," and without the citation of a specimen. I have not seen any specimens under this name and assume that if one existed it must have been destroyed in Berlin. Müller mentioned the name in connection with *C. lonchophyllum;* in view of his uncritical pyramiding of new species in his later years, it seems very likely that the name belongs in the synonomy of this species.

DISTRIBUTION: In dense, springy mats or clumps on bark and dead wood, or occasionally on rock, at altitudes up to 1000 m. From the specimens examined it seems that *C. lonchophyllum* occurs most frequently at moderate altitudes, ca. 300-600 m., along densely forested mountain slopes and valleys. The species is of wide occurrence around the Caribbean Sea, reaching its northern limit in the west in Guatemala and British Honduras and extending southeastward through Honduras, Nicaragua, and Costa Rica. No collections have been reported yet from either Panama or Mexico although the species probably occurs in parts of both countries. On the northern rim of the Caribbean *C. lonchophyllum* occurs abundantly in Cuba, Jamaica, and Puerto Rico, and has been found in Tortola in the Virgin Islands. It has been collected several times in Haiti but not in the Dominican Republic. Along the eastern margin of the Caribbean it occurs on all the major islands, including St. Kitts, Montserrat, Guadeloupe, Dominica, Martinique, St. Lucia, and St. Vincent, and continues into Tobago and Trinidad. In South America *C. lonchophyllum* occurs in eastern Venezuela, the Guianas, and throughout the northern half of the Amazon basin, with an apparently disjunct location far to the south in São Paulo, Brazil.

2. C. LEVYANUM Besch., Ann. Sci. Nat. 8, 1: 290. 1895. Plants dark green below, lighter above, dull, ca. 7(-15) mm. tall; upper part of leaves crispate when dry, usually forming one or more loops or curls, the lower part not much contorted; leaves spreading to erect when moist, straight, plane, mostly 6-8 mm. long, ca. 0.35 mm. wide, longest at apex of plant and decreasing in length downward, the upper often bearing brown, papillose-roughened, clavate propagula at the tip on the ventral surface of the costa; upper lamina linear, ca. 7 times longer than the sheathing base, the apex acute, especially on propaguliferous leaves, or obtuse, serrate; cancellinae (0.6-)0.8(-1.3) mm. long, about 1/5-1/7 the length of the leaf, broad and rounded above and usually conspicuously bulging upward on the ventral surface to form heavy ridges at the apices and part way down the sides; costa ending 2-3 cells below the apex, or sometimes shortly excurrent, stout, ca. 60-70 μ wide at midleaf, smooth on both sides except at the apex where it may be slightly roughened, the cross-section with 2 rows of guide

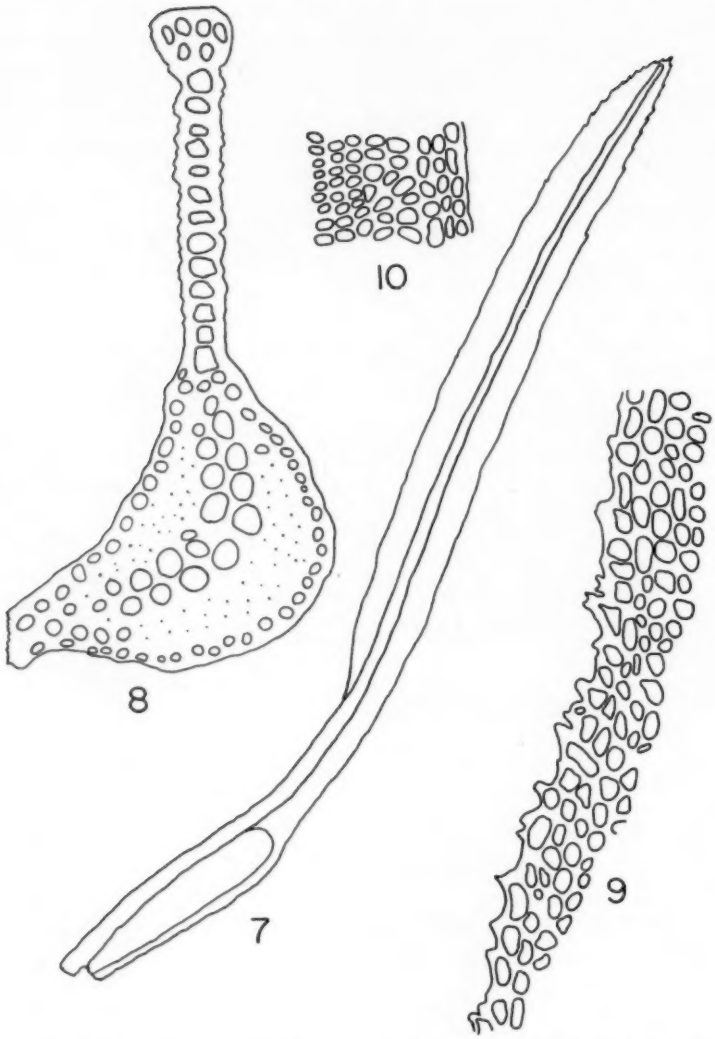

FIG. 7-10. *Calymperes levyanum*. 7. Leaf, × 23. 8. Cross-section of leaf, × 380. 9. Margin at leaf shoulder, × 380. 10. Margin and cells at midleaf, × 380. (Fig. 7-9 from *R. G. Robbins* 6, Panama. Fig. 10 from type.)

cells 8-10 μ in diameter and with stereid bands above and below the guide cells; cells at midleaf mostly 5-7 μ in greatest dimension, square or often transversely elongated, smooth or papillose on both

sides, those of the upper part of the leaf mostly square, obscure, densely papillose dorsally and ventrally, often slightly larger than those at midleaf, usually transversely elongated in the region just above the cancellinae; teniolae absent; margins greatly thickened from just above the shoulders to near the apex of the leaf, serrate toward the apex, coarsely serrate at the shoulders, triangular or nearly so in cross-section at midleaf and without stereid cells; perichaetial leaves shorter than stem leaves and with thinner margins. Capsule 1.8 mm. long, with a few stomata at the base, light yellow-brown, cylindric, the exothecial cells thin-walled; operculum ca. 1.7 mm. long, the beak subulate; seta 6 mm. long, red-brown, straight; calyptra plicate, slightly roughened above; spores 22-24 μ in diameter, finely roughened. (*Fig.* 7-10.)

TYPE: Nicaragua: *Levy* (without further data) (NY).

This seldom collected species is probably more abundant and more widely distributed than existing collections indicate, since it is very likely to be confused with and passed over as the common and closely related *C. lonchophyllum*. The obscure, densely papillose cells of the upper part of the leaf identify it at once under the microscope.

DISTRIBUTION: *C. levyanum* grows singly or in small clumps or cushions on bark or dead wood; it is apparently a plant of low elevations, occurring in coastal forests and river valleys. This species has been collected sporadically at several points along the western and northern borders of the Caribbean Sea. I have seen one collection each from Puerto Rico, Cuba, British Honduras, and Nicaragua and six collections from Panama and the Canal Zone.

3. C. VENEZUELANUM (Mitt.) Reese, Bryol. 60: 336. 1957. *Syrrhopodon venezuelanus* Mitt., Jour. Linn. Soc. 12: 125. 1869. *Calymperes lonchophyllum* Schwaegr. *sensu* Williams, Bull. Torrey Bot. Club. 47: 393. 1920, *pro parte*. *C. maguirei* Bartr., Bull. Torrey Bot. Club 75: 65. 1948. Plants light green, glossy, blackish in the older portions, ca. 15 mm. tall, the stems very short, the rhizoids sparse at the base; leaves suberect when dry, slightly curled, appearing somewhat secund, very fragile and mostly broken off near the middle, erect and straight when moist, up to 25 mm. long; upper lamina ca. 0.3 mm. wide, narrowly linear from the oblong, sheathing base which is ca. 2.5 mm. long, often bistratose, reduced to the bare costa for a distance of 2-3 mm. above the sheathing base; cancellinae acute or rounded above, almost entirely filling the leaf base, about 8 rows of cells wide; costa stout, ca. 150 μ wide near the apex of the cancellinae, smooth dorsally and ventrally, the cross-section with 3-4 median rows of small (ca. 6-7 μ

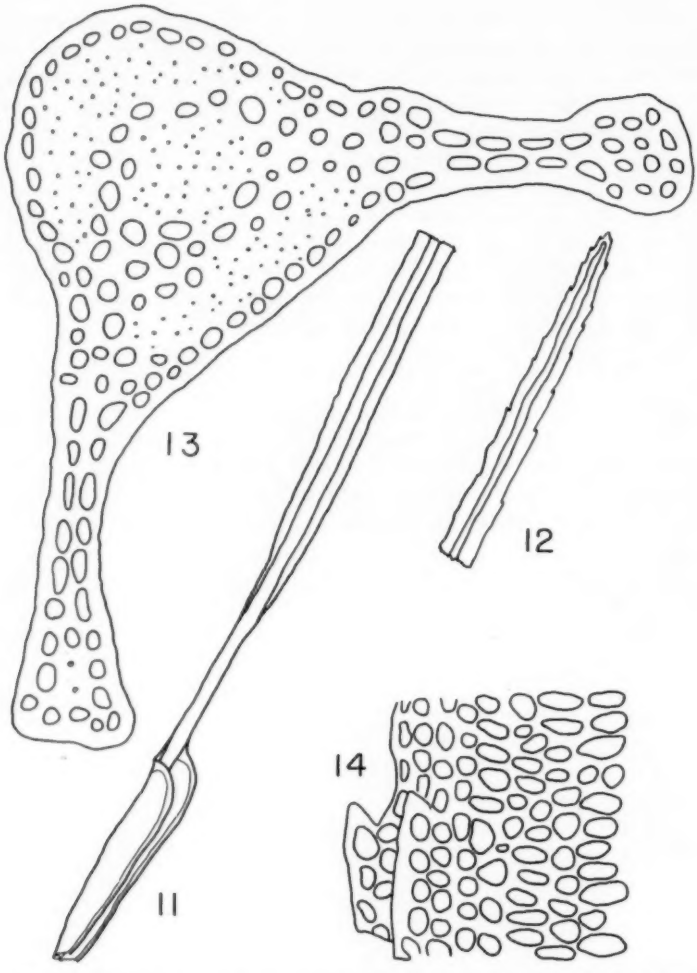

FIG. 11-14. *Calymperes venezuelanum*. 11. Leaf base, × 23. 12. Leaf apex, × 23. 13. Cross-section of leaf, × 380. 14. Margin and cells at midleaf, × 380. (Fig. 11, 13, and 14 from *B. Maguire* 24549m, Surinam. Fig. 12 from *C. V. Morton* 5987, St. Vincent.)

in diameter) guide cells, usually 2 or 3 rows above and 1 row below a ± circular bundle of stereids, and with bands of stereids above and below the guide cells, leaf cells transversely elongated, mostly ca. 7 × 12 μ, the walls thickened and the lumina appearing circular

or elliptical, smooth dorsally and ventrally; teniolae absent; margins of the upper lamina greatly thickened, minutely toothed below, more coarsely so toward the apex, triangular in cross-section and often enclosing a bundle of stereid cells; margins of the sheathing base unistratose, entire or serrate at the shoulders; plants apparently non-propaguliferous. Sporophytes unknown. (*Fig.* 11-14.)

TYPE: Venezuela: *Schomburgk* (no other data on specimen) (K, isotypes at H, NY).

C. venezuelanum is a very distinct species and one that would be difficult to confuse with any other except perhaps *C. lonchophyllum*. It may be distinguished immediately from the latter by its characteristically interrupted lamina and by the structure of the costa as seen in cross-section. Since none of the specimens bears sporophytes or propagula, it seems likely that reproduction occurs principally by regeneration of fragments of the very brittle leaves. Williams (1920) placed the name *Syrrhopodon venezuelanus* Mitt. in the synonomy of *Calymperes lonchophyllum;* the striking characteristic of the interval of bare costa between the upper and lower laminae, however, certainly serves to make the species distinct. In addition, the blackish color of the older portions of the plants and the wiry, suberect habit of the leaves are characteristic. The type specimen of *Calymperes maguirei* Bartr. (SURINAM: Precipitous east-facing slopes above escarpment, 300 m. south of East Ridge, Tafelberg, Oct. 29, 1944, *Maguire* 24549M, NY, isotypes at FH, BART) is identical to the type specimen of *C. venezuelanum*.

DISTRIBUTION: The species grows in dense, wiry cushions on soil(?) and bark at altitudes up to 750 m. The inadequate data associated with most of the specimens preclude all but the most generalized statements as to habitat. It seems most likely however, from the available data and from the aspect of the plants, that the species occurs in open areas on mountain slopes (east-facing in at least two cases) rather than in dense forests. Around the Caribbean the species is known from several collections from Jamaica and one from St. Vincent. In South America it is known from one collection each from Venezuela, British Guiana, Surinam, and "Guiana."

Subg. *Somphoneurum* Roth, Hedwigia 51: 124. 1912. Leaves mostly elliptic to lanceolate, not linear, upper lamina not more than three times the length of the lower; the costa in cross-section showing one or more median rows of large cells but no bands of stereid cells. Only one species is known from the Americas.

4. C. ULEANUM Broth., Hedwigia 34: 123. 1895. *C. cubense* Williams, Bull. Torrey Bot. Club 47: 387. 1920. Plants pale, yellowish green, often tinged with pink below, up to 20 mm. tall;

upper leaves strongly involute and falcate when dry, little contorted, the cancellinae very conspicuous and appearing white or, in the lower leaves, pinkish; leaves usually ascending when moist, up to 3.5 mm. long and ca. 0.6 mm. wide at the apex of the cancellinae, the upper often bearing filiform propagula, these up to 200 μ long and with about 8 cross-walls, on the ventral surface of the costa just below the leaf apex; upper lamina ligulate to lanceolate, the apex rather blunt, occasionally somewhat mucronate; lower portion of the leaf obovate in outline, entirely filled by the cancellinae except for a few rows of cells at the margins which include the teniolae; cancellinae broad and evenly rounded above, the apical cells usually highly mammillose and often not very sharply separated from the chlorophyllose cells of the upper lamina, 1/3-1/2 the length of the leaf; costa ending a few cells below the leaf apex, very strong, ca. 120 μ wide at the apex of the cancellinae and diminishing to ca. 80 μ wide near the leaf base, heavily papillose dorsally and ventrally to below the apex of the cancellinae; cross-section without stereid cells, usually with 2-4 rows of large cells 10-15 μ in diameter and several rows of smaller cells above and below; outer cells on the ventral surface usually highly mammillose-papillose, those of the dorsal surface smooth or sharply mammillose; leaf cells at midleaf mostly 6-10 μ in diameter, square to very irregular in outline, often somewhat elongated in the upper part of the leaf, smooth to finely papillose on the dorsal surface, highly mammillose to mammillose-papillose on the ventral surface; teniolae evident inside the leaf margins from just below the shoulders to about midleaf, then merging with the thickened margins, 2-3 cells wide, not more than 2-3 cells inside the margins; margins coarsely serrate at the shoulders, less strongly so to the apex, stereids or substereids present in the cross-section; perichaetial leaves not much different from the stem leaves, but shorter and the cancellinae not distinctly separated from the upper lamina. Capsule 2 mm. long, with a few stomata at the base, ovoid-cylindric, the exothecial cells thin-walled, oblong to rectangular, more or less sinuose; operculum rostrate from a flattened base ca. 4 mm. wide, the beak ca. 0.7 mm. long; seta dark red, straight, ca. 3.5 mm. long, somewhat papillose just below the capsule; calyptra smooth or only slightly roughened above, 3.5-4 mm. long; spores 17-24 μ in diameter, papillose-roughened. (*Fig.* 15-21.)

TYPE: Brazil: Goias, an Palmstammen am Tocantins, Oct. 1892, *E. Ule* 1556, (NY).

This rare plant is quite distinctive and is easily recognized by its extremely papillose costa, often much smaller at the base than

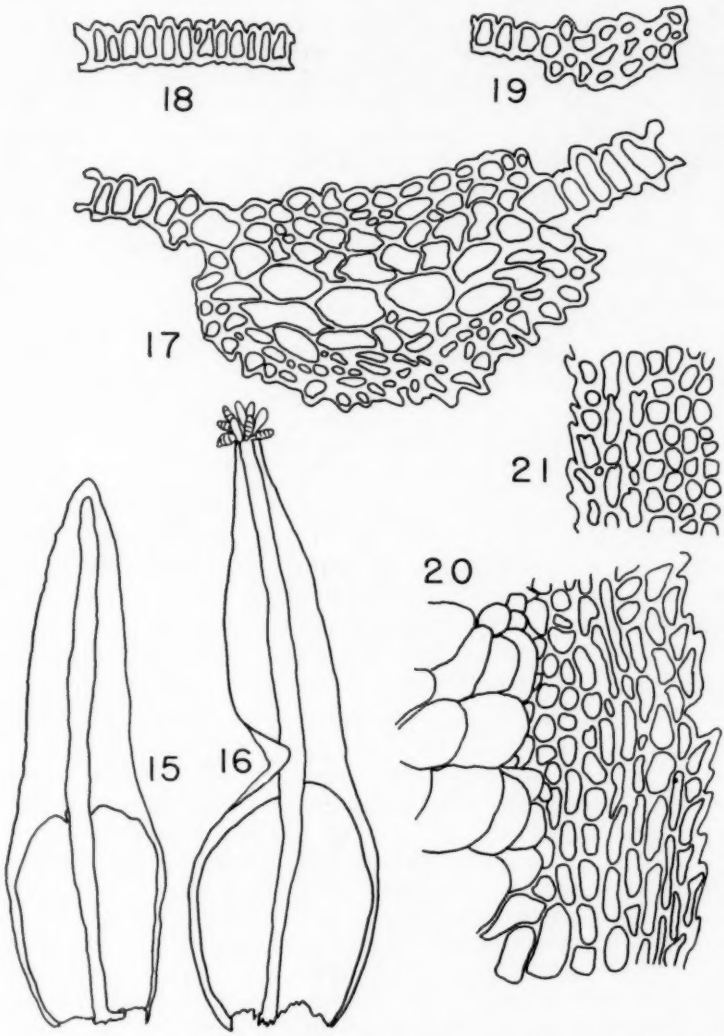

FIG. 15-21. *Calymperes uleanum*. 15. Non-propaguliferous leaf, × 23. 16. Propaguliferous leaf, × 23. 17. Cross-section of costa, × 380. 18. Cross-section of cells of lamina, × 380. 19. Cross-section of leaf margin, × 380. 20. Margin and cells at leaf shoulder, × 380. 21. Margin and cells at midleaf, × 380. (Fig. 15, 20, and 21 from *León & Clement* 6773, Cuba. Fig. 16-19 from *Fendler*, Trinidad.)

at the midleaf, and by the broad, evenly rounded cancellinae having the apical cells mammillose. The only species which could be confused with it is *C. erosum*, which is much less papillose and which has the cancellinae irregularly rounded at the apex. In addition, the structure of the costa as seen in cross-section is entirely different in the two. *C. uleanum*, the only American representative of the subgenus SOMPHONEURUM Roth, was evidently overlooked by Williams when he described *C. cubense*. I have examined the type collection of the latter (CUBA: Sierra de Gavilanes, Santa Clara, *León* and *Clement* 6773, NY); it agrees perfectly with the type of *C. uleanum*.

DISTRIBUTION: In thin patches on bark at low altitudes. This species seems to have a rather peculiar distribution, being known in the West Indies from one collection from Cuba, three collections (in the same general area) from Guadeloupe, and one collection from Trinidad. In South America it has been collected once in Surinam and twice in Brazil, in the states of Matto Grosso and Goias. It has been reported also from Colombia, but I have not seen the specimen. It is probable that this spotty distribution reflects more the lack of adequate collecting than the actual dispersal of the species.

Subg. *Hyophilina* (C. M.) Broth. *in* E. & P., Nat. Pfl. 1(3): 374. 1901. *Hyophilina* C. M., Syn. 1: 523. 1849 (as a *sectio*). Leaves elliptic, broadly to linear-lanceolate, or subulate, the upper lamina only rarely more than three times the length of the lower; the costa in cross-section showing a median row of guide cells with stereid cells arranged in bands above and below. Twelve species are known from the Americas.

5. C. NASHII Williams, Bull. Torrey Bot. Club 47: 391. 1920. Plants small, 2-3(-7) mm. tall, light green and lustrous when dry; leaves involute and incurved or somewhat contorted when dry, in some plants secund, erect to widely spreading when moist and often remaining somewhat channeled, 2-2.5 mm. long and up to 0.7 mm. wide, mostly bearing abundant propagula on all sides of the costa at the apex; propagula up to 200 μ long, clavate, with about 12 cross-walls, easily visible with a handlens as a whitish ball at the apex of the leaf; upper lamina oblong to oblong-ovate above the scarcely sheathing base, widest above the middle, mostly obtuse, sometimes acutish; cancellinae narrow, rectangular, occupying about half of the leaf base, squared above or occasionally irregular, often not sharply differentiated from the upper lamina, 1/6-1/3 the length of the leaf, the cells mostly square, sometimes rectangular; costa stout, excurrent, or in the few non-propaguliferous leaves percurrent or ending a few cells below the apex, ca. (46-)70(-90) μ wide at the apex of the cancellinae, heavily papillose-roughened dorsally and ventrally near the leaf apex and on

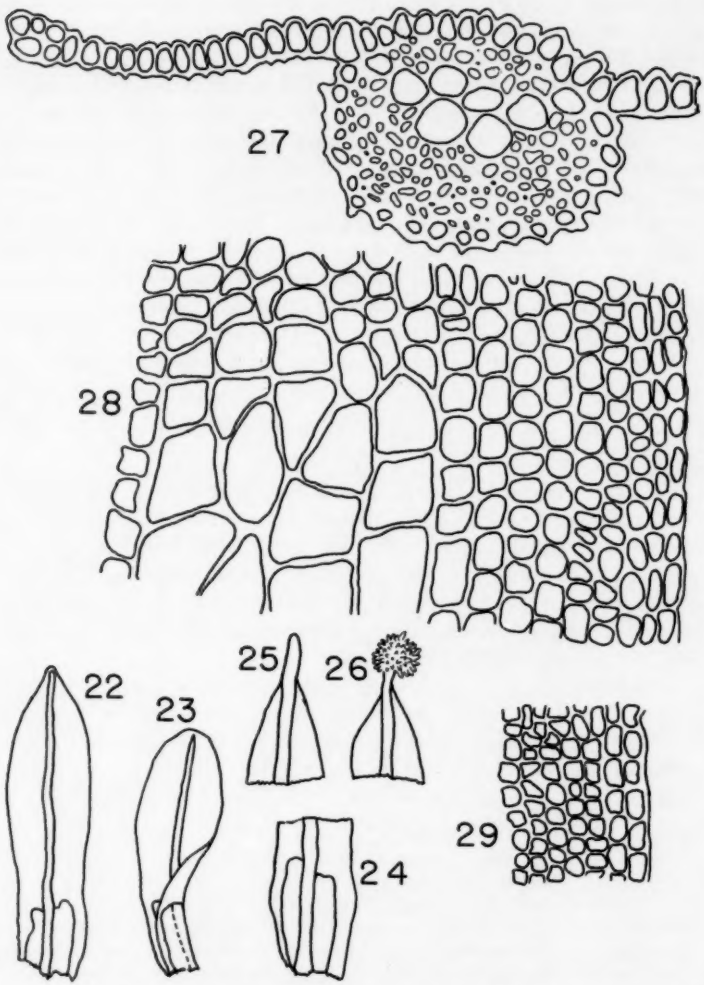

FIG. 22-29. *Calymperes nashii*. 22-23. Leaves, × 23. 24. Leaf base, × 23. 25-26. Apices of propaguliferous leaves, × 23. 27. Cross-section of leaf, × 380. 28. Margin and cells at apex of cancellinae, × 380. 29. Margin and cells at midleaf, × 380. (Fig. 22-24 and 27 from *W. S. Phillips* 100, Florida. Fig. 25-26 from type. Fig. 28 from *N. L. Britton et al.* 1860, Puerto Rico. Fig. 29 from *J. K. Small* & *C. Mosier* 5158, Florida.)

the excurrent portion, dorsally slightly papillose or smooth to below midleaf, ventrally smooth or mammillose, the cross-section with about 5 guide cells and occasional accessory guide cells, and stereid bands above and below the guide cells, the outer cells differentiated on the ventral surface, those of the dorsal surface usually stereids or substereids; cells at midleaf square, 6-8 μ in diameter, finely papillose dorsally, mammillose ventrally, larger and with thicker walls just above the cancellinae; teniolae none or occasionally present as vestiges consisting of from 1-few narrowly elongated, hyaline cells, 3-4 cells in from the leaf margins and just above the apex of the cancellinae; leaf margins entire, bistratose from above the cancellinae to just below the leaf apex, in the basal part composed of square or only slightly elongated, chlorophyllose cells, in cross-section showing a bundle of 3-4 cells with no stereids. Sporophytes unknown. (*Fig. 22-29.*)

TYPE: Haiti: Bayeux near Port Margot, sea level, on tree, 3 Aug. 1903, *G. Nash* 51 (NY).

Calymperes nashii, known from a few localities only, seems to be a rather rare species, although its minute size may account in part for the paucity of collections. In the field it may easily be passed up as a small form of *C. richardii.* One of the outstanding features of *C. nashii,* apart from its small stature, is the abundance with which propagula are produced. Nearly all the leaves on every plant are propaguliferous. This species may be distinguished from *C. richardii* in the field by observing the arrangement of the propagula which in *C. richardii* are produced only on the ventral surface of the costa, whereas in *C. nashii* they are borne on all sides. Under the microscope the absence of strong teniolae, the narrow, rectangular cancellinae, and the square or only slightly elongated cells of the basal margins are distinctive.

DISTRIBUTION: In loose clumps or in thin colonies on bark or dead wood, at or near sea level. It is a species of semi-xeric habitats, occurring in and around hammocks and in the scrubby jungle of the Florida Keys. The largest plants seen came from the interior of a live oak-cabbage palm forest on Key Largo where the species was collected in 1940 by W. S. Phillips and again, in 1957, by the author. This species is known from three localities in southern Florida and from one collection each from northern Haiti and Puerto Rico (Mona Island).

6. C. RUFUM Herz., Beih. Bot. Zentralbl. 61: 585. 1942. Plants reddish-brown, small, up to 2 mm. tall, unbranched; leaves ascending when dry but ± curved in toward the stem, spreading when wet, mostly about 1.5 mm. long and up to 0.3 mm. broad, without shoulders; non-propaguliferous leaves ligulate; propaguliferous leaves involute above and with an expanded apex; propagula cla-

vate, composed of about 6 cells, up to ca. 170 μ long, borne on the ventral surface of the costa at the apices of modified upper leaves; cancellinae small, narrowly rectangular in outline, somewhat rounded apically and usually separated from the costa above; costa strong, dark brown, (40-)45-55(-60) μ wide at the apex of the cancellinae, smooth or nearly so dorsally and ventrally, in cross-section showing a median row of 4-6 guide cells with bands of stereids above and below, the outer cells not differentiated; cells at midleaf with rather thick walls, arranged in vertical rows, rounded or nearly square, uniformly ca. 13 μ in diameter, evenly bulging dorsally and ventrally; teniolae absent; margin of the upper lamina unistratose, evenly crenulate by protruding cells from the vicinity of the apex of the cancellinae to the tip of the leaf; margin of the lower lamina entire, composed of large, vertically elongated, hyaline cells. Sporophyte unknown. (*Fig.* 30-34.)

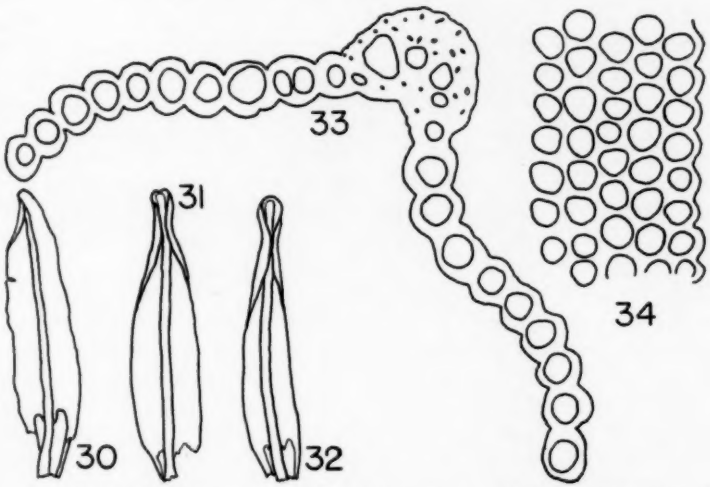

FIG. 30-34. *Calymperes rufum*. 30-32. Leaves, × 22. 33. Cross-section of leaf, × 320. 34. Margin and cells at midleaf, × 320. (All figures from type.)

TYPE: Brazil: Amazongebiet . . . (partly illegible), *Franck* (in herb. T. Herzog, Jena). Although the original description implies that the type specimen is located in the Munich herbarium, the herbarium staff was not able to locate the specimen. The single collection I examined was lent by Dr. T. Herzog, Jena.

This very distinct little species, known only from the original collection, has no close relatives among American *Calymperes* and may well prove to belong in the genus *Syrrhopodon* when the

sporophyte is discovered. The species is best characterized by its narrow cancellinae, its unistratose, crenulate margins, the absence of teniolae, and the rather large, rounded, thick-walled cells of the upper lamina.

7. C. RICHARDII C. M., Syn. 1: 524. 1849. *C. breutelii* Besch., Ann. Sci. Nat. 8, 1: 278. 1895. *C. guadeloupense* Besch., Ann. Sci. Nat. 8, 1: 285. *C. hexagonum* Besch., Ann. Sci. Nat. 8, 1: 286. 1895. *C. hookerii* Besch., Ann. Sci. Nat. 8, 1: 287. 1895. *C. panamae* Besch., Ann. Sci. Nat. 8, 1: 298. 1895. *C. perinvolutum* C. M., Flora 83: 332. 1897. *C. bahiense* C. M., Hedwigia 39: 261. 1900. *C. aberrans* Par., Rev. Bryol. 33: 37. 1906. *C. brevicaule* Par. & Broth., Rev. Bryol. 33: 37. 1906. Plants 3-10(-20) mm. tall, dark glossy green when collected, becoming lighter in the herbarium; leaves when dry involute and curved or somewhat curled, often appearing secund, when wet erect-spreading at an angle of about 45°, (1-)2-3(-4) mm. long and 0.5-1(-1.5) mm. wide, the upper usually bearing dense clusters of filiform-clavate propagula up to about 300 μ long, on the ventral surface of the leaf just below the apex, or rarely the propagula produced singly or in 2's or 3's along the ventral surface of the costa down to about midleaf; upper lamina of non-propaguliferous leaves oblong, oblong-ovate, or spatulate, obtuse to broadly acute at the apex, often somewhat mucronate, broadest above or below the middle; sheathing base variable, as wide as or wider than the upper lamina to much narrower, often forming slight shoulders at the apical region of the cancellinae, in outline ranging from nearly cuneate to oblong or square; upper lamina of propaguliferous leaves lanceolate to oblong-lanceolate or merely oblong, usually abruptly narrowed and revolute above to just below the spatulate apex where the propagula are borne; cancellinae mostly ending in broad angles above, usually occupying most of the leaf base and consisting of about 9(-14) rows of rectangular to quadrate cells which decrease in size toward the margins and are sharply separated from the green cells of the upper lamina above, composing ca. 1/4-1/3 the length of the leaf; costa usually stout, especially in propaguliferous leaves, (45-)70-100(-120) μ wide at the apex of the cancellinae, ending a few cells below the apex of the leaf, smooth dorsally except toward the apex, mammillose ventrally, especially in the apical part, the cross-section showing a median row of about 4-6 guide cells and occasional accessory guide cells, and bands of stereid or substereid cells (rarely lacking) dorsal and ventral with respect to the guide cells, the outer cells differentiated ventrally and usually dorsally; cells at midleaf (6-)7-8(-10) μ in diameter, variable in shape but

usually rounded or quadrate, smooth or minutely papillose dorsally, mammillose ventrally, mostly rather thin-walled but occasionally with thick walls and small lumina; teniolae 1-3 cells in from the margins at the apex of the cancellinae, (1-)2-3(-5) cells wide at the same point, continuous from below the apex of the cancellinae to near or well above the midleaf, running just inside the margins; leaf margins entire above and strongly serrate to entire in the basal part, unistratose or, more often, thickened from above the shoulders to near the apex of the leaf, the marginal cells elongated and hyaline in the basal part of the leaf, quadrate and chlorophyllose above; perichaetial leaves shorter than the stem leaves, their bases broader and more sheathing, the cancellinae larger and with smaller and more irregular cells. Capsule 1.2-2 mm. long, with a few stomata at the base, cylindric to short-cylindric, hyaline except the region of the mouth which is dark brown, usually somewhat constricted at the mouth, the exothecial cells thin-walled, irregular in shape, mostly square to oblong; operculum ca. 0.5 mm. long, rostrate; seta ca. 3 mm. long, dark; calyptra 3-3.2 mm. long, plicate, smooth; spores (20-)28-35(-40) μ in diameter, finely papillose. (*Fig.* 35-43.)

TYPE: Brazil Pernambuco, June 1838, *G. Gardner* 47 (K, isotype at OXF). In the original description of *C. richardii* Müller cited specimens as follows: "*Patria: Per totam Guianam, Gallicam, Anglicam et Batavicam: Richard, Schomburgk, Kegel. Brasilia ad Pernambuco: Gardner Coll. No.* 47." The only one of these specimens which I have been able to identify with certainty is that of Gardner, and since no type specimen has heretofore been designated for this species, Gardner's collection no. 47 may be designated the lectotype.

Calymperes richardii is a well-marked species and is not easily confused with any other. It is readily recognized in the field by its dark green, glossy appearance, and by the conspicuous clusters of propagula, on the ventral surface only, at the tips of the upper leaves. Under the microscope the broad, rectangular cancellinae, the oblong or spatulate leaves, and the smooth cells will distinguish it at once.

I have examined the types of *C. breutelii* Besch. (ÎLE SAINT-THOMAS: Antilles, 1841, *J. C. Breutel*, NY), *C. guadeloupense* Besch. (GUADELOUPE: *Marie*, NY), *C. hexagonum* Besch. (ST. THOMAS: In saxis humidis sylvularum et ad torrentes, 1782-1789, *C. Richard*, S-PA), *C. hookeri* Besch. (ANTIGUA: Antilles, without further data PC), *C. panamae* Besch. (PANAMA: 1850, *Duchassaing*, NY), *C. perinvolutum* C. M. (VENEZUELA: Tovar, *Goebel*, NY), *C. bahiense* C. M. (BRAZIL: Bahia, *A. Boden*, NY, isotype at H), *C. aberrans* Par. (GUIAN. GALL.: Mtgne. des Peres,

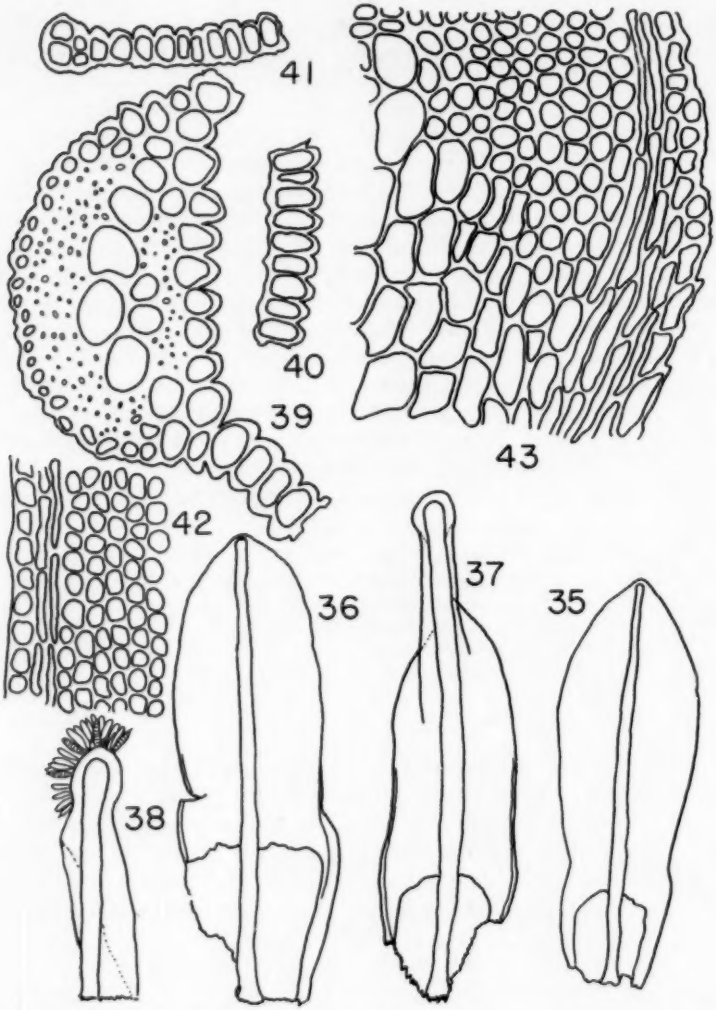

FIG. 35-43. *Calymperes richardii*. 35-36. Leaves, × 23. 37. Propaguliferous leaf, × 23. 38. Apex of propaguliferous leaf, × 23. 39. Cross-section of costa, × 380. 40. Cross-section of cells of lamina, × 380. 41. Cross-section of leaf margin, × 380. 42. Margin and cells at midleaf, × 380. 43. Margin and cells at leaf shoulder, × 380. (Fig. 35 and 37 from *F. McFarlin* 524, Florida. Fig. 36 and 38 from *N. L. Britton et al.* 10, St. Thomas. Fig. 39-41 from *E. G. Britton 7292*, Cuba. Fig. 42-43 from *C. F. Austin* & *J. D. Smith*, Florida.)

ad rupes, 22/X-1906, *Galliot,* REN), and *C. brevicaule* Par. & Broth. (GUIAN. GALL.: Macouria, ad arborem emortuam, 1906, *Galliot,* NY). None of these specimens differs in any significant way from typical *C. richardii.* It is inevitable that a widely ranging species will pick up a good deal of synonomy over the years but it is difficult to understand how such a well-defined species as *C. richardii* could be named so often. A survey of the type specimens of the various names leaves one just as confused since in the majority of cases the types do not even represent extremes or puzzling variants.

DISTRIBUTION: In low, dense mats on bark or dead wood, or occasionally on rocks, mostly at or near sea level but with occasional specimens found up to ca. 700 m. It is a species of coastal forests and hammocks in areas of moderate rainfall (over 1000 mm. annually). The plants seem to be highly resistant to desiccation and, in Florida at least, exist in abundance along the Keys in the scrub thickets and in the interiors and around the margins of the hammocks which, between rains, become extremely dry. It is one of the most common species of the southern Florida hammocks and the Keys. *C. richardii* has a wide distribution around the Caribbean Sea. It reaches its northern limit in the west at about the latitude of Veracruz, Mexico, and extends southeastward through Central America to the Canal Zone. It is known from the Yucatan Peninsula, British Honduras, northern Guatemala, Nicaragua, Costa Rica, and Panama, with a number of collections from the Canal Zone but only two from Panama east of the Canal Zone. In the east *C. richardii* reaches its northern limit at a little below 29° N. Lat. in Sumter County, Florida. It has been reported from Duval County, in the northeastern corner of the state, but I have not seen a specimen. Outside of Florida, in the eastern part of its range, *C. richardii* occurs in the northern Bahamas and in western Cuba, in the provinces of Pinar del Río and Oriente (one collection), and is found also in Jamaica, Haiti, Puerto Rico, and the Virgin Islands. To the south the species has been collected through the major Leeward and Windward Islands, from St. Kitts to St. Vincent, as well as on Tobago and Trinidad. In South America the distribution of *C. richardii* is very poorly known, as is true for all other species as well, because of the scarcity of collections from large areas of the continent. It seems to occur most abundantly across the Guianas with only a relatively few collections elsewhere, *viz.,* from northern Colombia, western and northeastern Venezuela, and scattered localities in Brazil to about 15° S. Lat. Charles Darwin collected this species on the island of Fernando de Norontha, to the east of Brazil's hump, in the Atlantic Ocean.

8. C. PLATYLOMA Mitt., Jour. Linn. Soc. 12: 128. 1869. Plants up to 6 mm. long; leaves involute and curved upward when dry, spreading and remaining channeled when wet, 3.5-4(-4.5) mm. long, up to 0.9 mm. wide at the shoulders; upper lamina narrowly lanceolate to almost linear, lower lamina obovate to elliptic, ca. 1/3 the length of the upper lamina; propagula not produced(?); cancellinae broad and irregular above, narrowing below, apically flattened or irregularly rounded, extending only about 1/2 the length of the lower lamina; costa nearly or quite percurrent, (65-)75-85

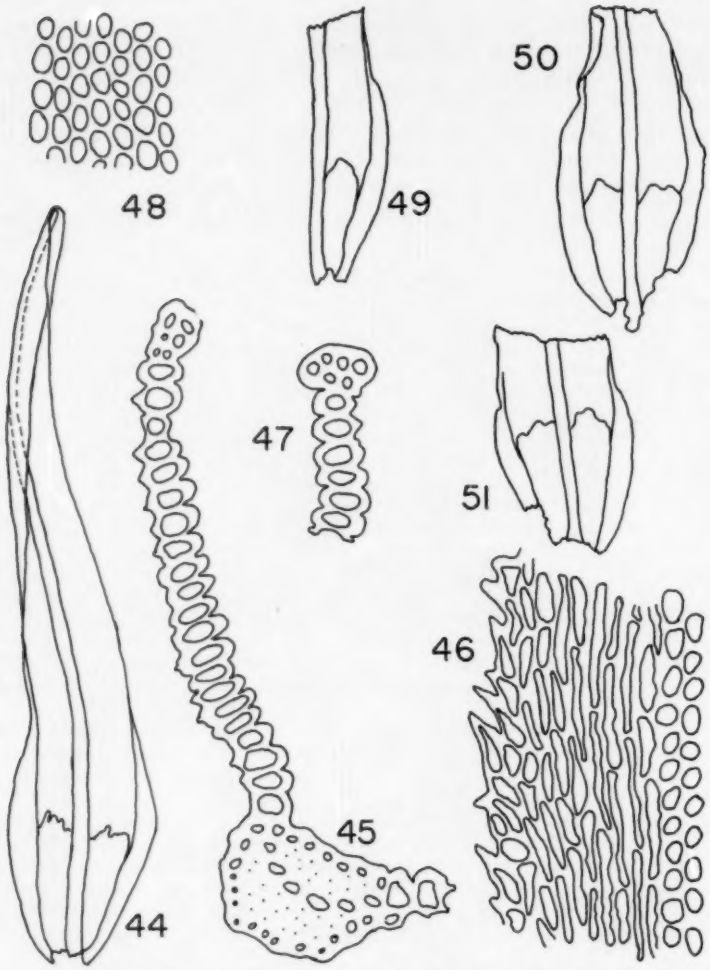

FIG. 44-51. *Calymperes platyloma*. 44. Leaf, × 22. 45. Cross-section of leaf, × 320. 46. Margin and teniola just above leaf shoulder, × 320. 47. Cross-section of margin, × 320. 48. Cells at midleaf, × 320. 49-51. Leaf bases, × 22. (All figures from type.)

(-90) μ wide at the apex of the cancellinae, papillose-roughened dorsally in the upper half, smooth or nearly so below, papillose to mammillose ventrally in the upper half, smooth below, cross-section with 4-6 median guide cells and bands of stereids above and below,

outer cells differentiated on the ventral surface, obscurely so dorsally; lamina cells at midleaf rounded-rectangular, thick-walled, vertically elongated, ca. (10-)12-14(-17) × 8 μ, papillose to mammillose-papillose on the dorsal surface, bulging-mammillose ventrally; teniolae very strong, intramarginal for a very short distance above the leaf shoulders, then becoming very broad below and occupying the entire area between the cancellinae and the margin of the lower lamina, composed of elongated, hyaline, cells, with the walls thickened and pitted; margins of the upper lamina thickened, slightly involute, evenly serrulate by projecting cell angles, in cross-section showing a few thick-walled cells in a group, with an occasional stereid; margins of the lower lamina unistratose, sharply and irregularly serrate from the shoulders nearly to the insertion; perichaetial leaves with the upper lamina reduced and the cancellinae very irregular. Capsule short-cylindric, ca. 1.8 mm. long, without stomata, exothecial cells ± rectangular, thin-walled and arranged in sinuous, vertical lines; operculum conic, ca. 0.75 mm. long; spores irregularly rounded, very minutely roughened, 18-22 μ in diameter; calyptra slightly roughened at the apex, ca. 3.5 mm. long; seta short, ca. 3 mm. long, (*Fig.* 44-51.)

TYPE: British Guiana: *C. F. Appun* 819 (without further data) (K, isotype at NY). Apparently Appun's collection of this species is the only one ever made. Part of this collection is at Kew; the remainder is in Mitten's Herbarium at the New York Botanical Garden. A specimen collected by Schomburgk in British Guiana, found in several herbaria under the name *C. platyloma*, is *C. richardii*.

The most striking characteristic of this species is the great development of the teniolae in the leaf base. The very wide teniolae, the broadest in the genus (at least in the Americas), together with the rather regular serrulation of the margins of the upper lamina, distinguish *C. platyloma* from *C. lanceolatum*, which also has rather broad basal teniolae. In the latter species, however, the margins of the upper lamina bear large, irregular teeth, in pairs. *C. smithii*, which also has basal, marginal teniolae, differs in that the teniolae are usually less than six cells wide at the most, whereas those of *C. platyloma* may exceed 14 cells in width at the broadest part. In addition, the margins of the upper lamina in *C. smithii* are strongly and irregularly serrate. Both *C. smithii* and *C. lanceolatum* have the leaf cells smooth or merely bulging dorsally, whereas in *C. platyloma* the leaf cells are papillose.

9. C. LANCEOLATUM Hampe, Vid. Medd. Naturh. For. Kjoebenh. 4, 1: 78. 1879. Plants somewhat glossy, olive green, up to 15 mm. long, unbranched, mostly arcuate, julaceous when dry;

leaves closely appressed to the stem when dry, not at all contorted, ascending and nearly plane or somewhat channeled when wet, (3.5-)4-5(-5.5) mm. long and up to ca. 1.4 mm. wide at the shoulders of the lower lamina; upper lamina of the non-propaguliferous leaves narrowly linear-lanceolate, of the modified, propaguliferous leaves subulate and often reduced apically to bare costa, in either case arising abruptly from the broadly flaring, obovate lower lamina; propagula short-clavate, ca. 150-175 μ long, borne on the ventral surface of the costa at the apices of the upper leaves; cancellinae ± rounded above or sometimes terminating in obtuse angles next to the costa, only slightly narrowed below, ± rectangular to broadly obovate in outline, nearly filling the basal half of the lower lamina but extending only about 1/2-2/3 of the distance from the insertion to the shoulders of the leaf; costa stout, ca. (90-)100-115(-130) μ wide at the apex of the cancellinae, smooth or with a few low papillae dorsally and ventrally except at the somewhat roughened apex, ending a few cells below the apex of the leaf or, in propaguliferous leaves, shortly excurrent, in cross-section showing a median row of 6-8 guide cells with thick bands of stereid cells above and below, outer cells differentiated dorsally and ventrally; cells at midleaf thick-walled, rounded-rectangular, mostly somewhat vertically elongated, arranged in vertical rows parallel with the costa, smooth or somewhat bulging on the dorsal surface, mammillose to highly bulging ventrally, ca. 5 × 8 μ to 8 × 16 μ; teniolae confined to and forming the margins of the lower lamina, from 2-7 cells wide at the base of the thickened margin of the upper lamina up to ca. 14 cells wide at the often flaring shoulders of the lower lamina, composed mostly of short cells which have pointed ends and thickened, often pitted and somewhat sinuose walls, occasionally much reduced or absent in some leaves; margins of the upper lamina thickened, plane, obscurely to strongly and irregularly toothed with the teeth occurring in pairs, in cross-section irregular in outline, composed of several large, thick-walled cells, occasionally including a stereid cell; margins of the lower lamina unistratose, nearly entire to serrulate or strongly and irregularly serrate. Sporophyte unknown. (*Fig.* 52-58.)

TYPE: Brazil: Rio de Janeiro, Corcovado, 7 July 1878, *A. Glaziou* 9278 (H, isotypes at PC, BM).

C. lanceolatum is a well-marked species and is best characterized by the broad, often flaring shoulders of the lower lamina, the broad, basal, marginal teniolae, and the non-papillose cells of the upper lamina. *C. smithii* differs in having much narrower teniolae and

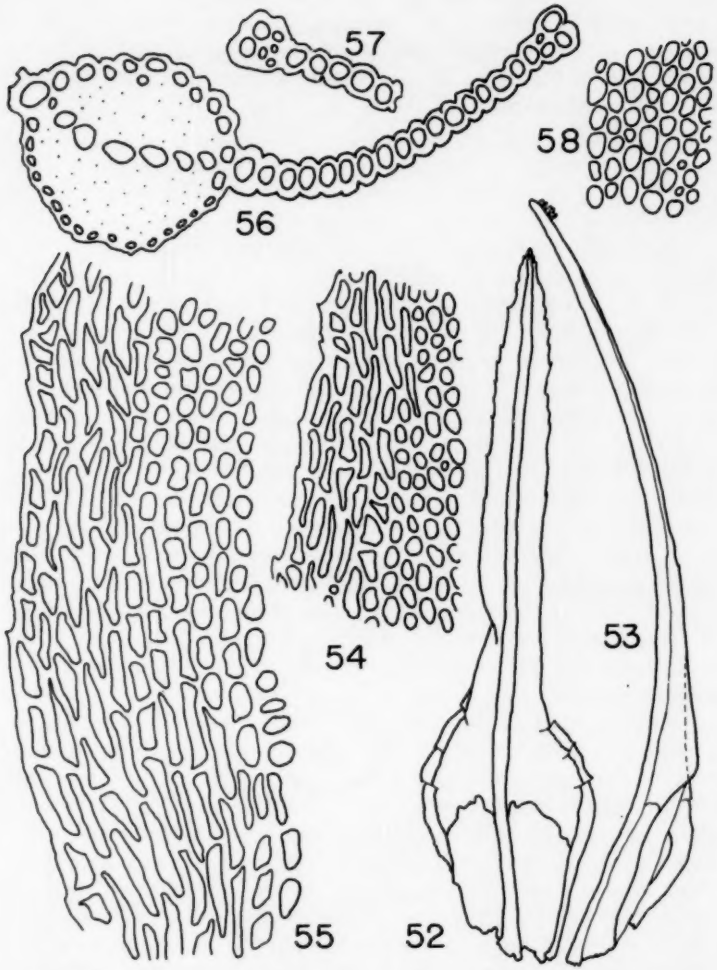

FIG. 52-58. *Calymperes lanceolatum*. 52. Leaf, × 22. 53. Propaguliferous leaf bearing immature propagula, × 22. 54. Margin and teniola just above leaf shoulder, × 320. 55. Margin and teniola at shoulder, × 320. 56. Cross-section of leaf, × 320. 57. Cross-section of margin, × 320. 58. Cells at mid-leaf, × 320. (All figures from type.)

less acuminate leaves; *C. platyloma*, the closest relative of *C. lanceolatum*, differs in having the lower lamina less broadly flaring, the cells of the upper lamina distinctly papillose dorsally, and the

margin of the upper lamina evenly serrulate. Sterile plants of *Syrrhopodon curvatus* C. M., with which *C. lanceolatum* has been confused, differ very evidently in lacking teniolae and in having the margins of the upper lamina heavily toothed, but with the teeth single rather than in pairs.

DISTRIBUTION: In dense clumps on bark. The species is known from only one collection besides the type (BRAZIL: Santa Catarina, Mata do Hoffman, Brusque; epifito, da mata, alt. 50 m.s.m., 27.11.1949, *P. R. Reitz* 3.148, BART, HBR).

10. C. MEYERI Reese, Bryol. 60: 336. 1957. Plants in the herbarium light yellowish-green, loosely caespitose, ca. 3 mm. tall; leaves spreading when dry, or appressed and secund, involute, spreading or ascending when wet, 2.5-3(-3.5) mm. long and ca. 0.5 mm. wide; upper lamina oblanceolate or elliptic, broadest above the middle; sheathing base ± cuneate, forming shoulders in the upper part above which the lamina is constricted for a short distance; apex usually obtuse, sometimes pinched off so that slight shoulders are formed, elongated in propaguliferous leaves; propagula clavate, ca. 150 μ long, borne in clusters on the ventral surface of the leaf near the apex; cancellinae terminating in acute angles above, not very sharply differentiated from the cells of the surrounding lamina, nearly filling the leaf base and extending above the shoulders, composed of ca. 8 rows of square or short-rectangular cells, about 1/6 the length of the leaf; costa 50-60 μ wide at the apex of the cancellinae, smooth dorsally in the lower part, somewhat roughened near the apex, ± papillose ventrally, especially in the upper half, ending a few cells below the apex of the leaf or percurrent, the cross-section showing 4-6 guide cells with thick bands of stereids above and below, the outer cells differentiated dorsally and ventrally; cells at midleaf very irregular in shape, square to rectangular or rounded, mostly 5 × 5-6(-8) μ, mammillose-papillose ventrally and minutely papillose dorsally, becoming larger toward the leaf base and more or less intergrading with the hyaline cells of the cancellinae; teniolae restricted to the upper part of the leaf base or present nearly to the insertion, marginal, consisting of 2-4 rows of mostly elongated, thick-walled, yellowish cells, usually disappearing rather abruptly above at the point where the leaf margin becomes thickened, or remaining distinct for a short distance inside the margin; margins serrate in the lower part of the leaf, doubly and more coarsely so in the upper part, entire to coarsely serrate in the apical region, thickened from the apex of the cancellinae to just below the leaf apex, in cross-section triangular to rectangular and composed of a ring of large cells, sometimes enclosing a few stereids. Sporophyte unknown. (*Fig.* 59-67.)

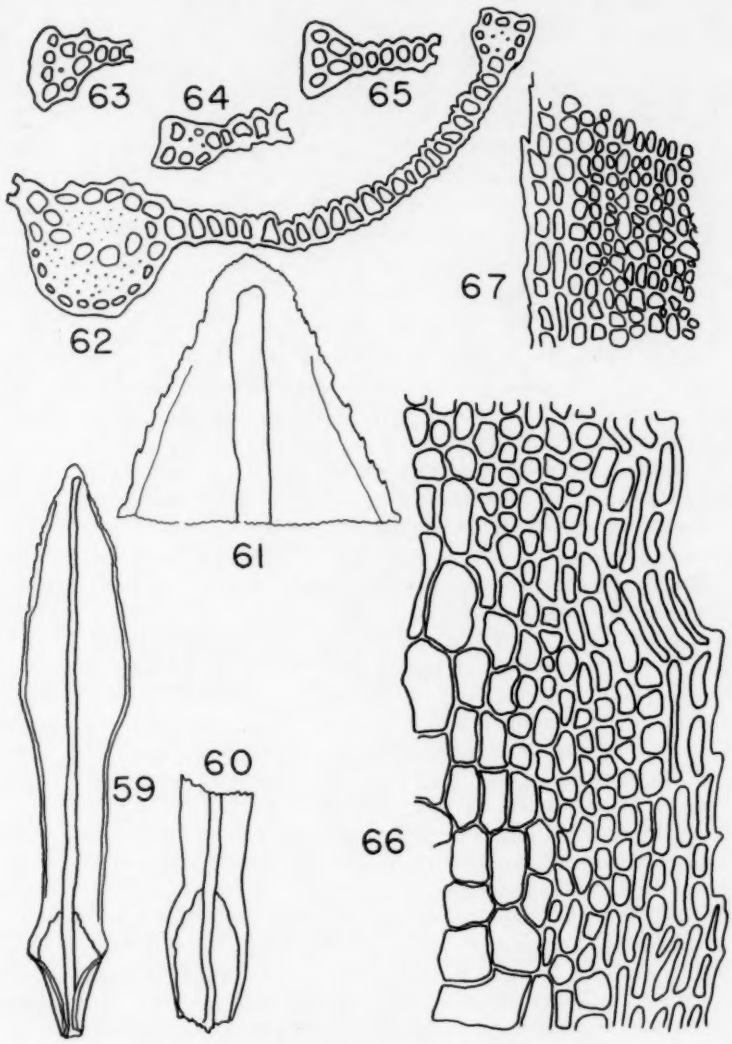

FIG. 59-67. *Calymperes meyeri*. 59. Leaf, × 23. 60. Leaf base, × 23. 61. Leaf apex, × 100. 62. Cross-section of leaf, × 380. 63-65. Cross-sections of leaf margin, × 380. 66. Margin and cells at leaf shoulder, × 380. 67. Margin and cells at midleaf, × 380. (All figures from type.)

TYPE: Panama: Tree trunk, Barro Colorado Island, Canal Zone, 21 July, 1944, *S. L. Meyer* 7 (TENN).

This species may be distinguished from *C. platyloma, C. smithii,* and *C. lanceolatum,* all of which have the teniolae more or less marginal along the lower lamina, by the fact that in *C. meyeri* the cancellinae extend above the leaf shoulders while in the other three the cancellinae terminate well below the shoulders. The presence of the teniolae serves to distinguish the species immediately from small forms of *Syrrhopodon incompletus.*

DISTRIBUTION: Loosely caespitose on dead wood; known only from the type locality in the Canal Zone, where it was found growing with *C. donnellii.*

11. C. SMITHII Bartr., Bull. Torrey Bot. Club 66: 223. 1939. Plants up to 1 cm. tall, olive-green, unbranched; leaves ± appressed when dry, spreading when wet, mostly (3-)3.5(-4) mm. long and up to ca. 1 mm. wide at the shoulders of the lower lamina; upper lamina of the non-propaguliferous leaves oblong-elliptic, in the propaguliferous leaves greatly modified and reduced to narrow wings along both sides of the highly papillose costa with a flaring area at the apex, in either case arising abruptly from the flaring (often highly so) shoulders of the obcuneate lower lamina; propagula not abundant, produced on the ventral surface of the costa mostly at the apices of modified upper leaves, clavate, up to ca. 250 μ long; cancellinae irregularly rounded or flattened apically, broadly obovate to rectangular in outline, extending about half-way up the lower lamina; costa strong, (74-)80-95(-100) μ wide at the apex of the cancellinae, smooth dorsally in the lower part, papillose-roughened at midleaf and becoming spinose toward the apex, especially on the propaguliferous leaves, smooth below ventrally, becoming roughened in the central portion and spinose at the apex, in cross-section showing 4-6 median guide cells with bands of stereid cells above and below and with the outer cells differentiated; cells at midleaf arranged in vertical rows, rounded to oblong, mostly about 8-11.5 μ × 8 μ, ± highly bulging dorsally and ventrally; teniolae marginal along the lower lamina, extending downward to the insertion, gradually merging with the thickened margin of the upper lamina above the shoulders, at the shoulders consisting of 3-6 rows of elongated, thick-walled, hyaline cells; margins of the upper lamina rarely unistratose, usually thickened, entire or slightly serrulate in the lower portion, becoming narrowly winged and coarsely and irregularly serrate and spinose in the upper part, in cross-section showing a group of 2-several thick-walled cells with a few stereid cells occasionally present; margins

of the lower lamina entire below, entire or remotely and irregularly serrate in the vicinity of the shoulders. Sporophyte unknown. (*Fig.* 68-74.)

TYPE: Brazil-British Guiana Boundary: Akarai Mountains, height of land between drainage of Rio Mapuera (Trombetas tributary) and Shodikar

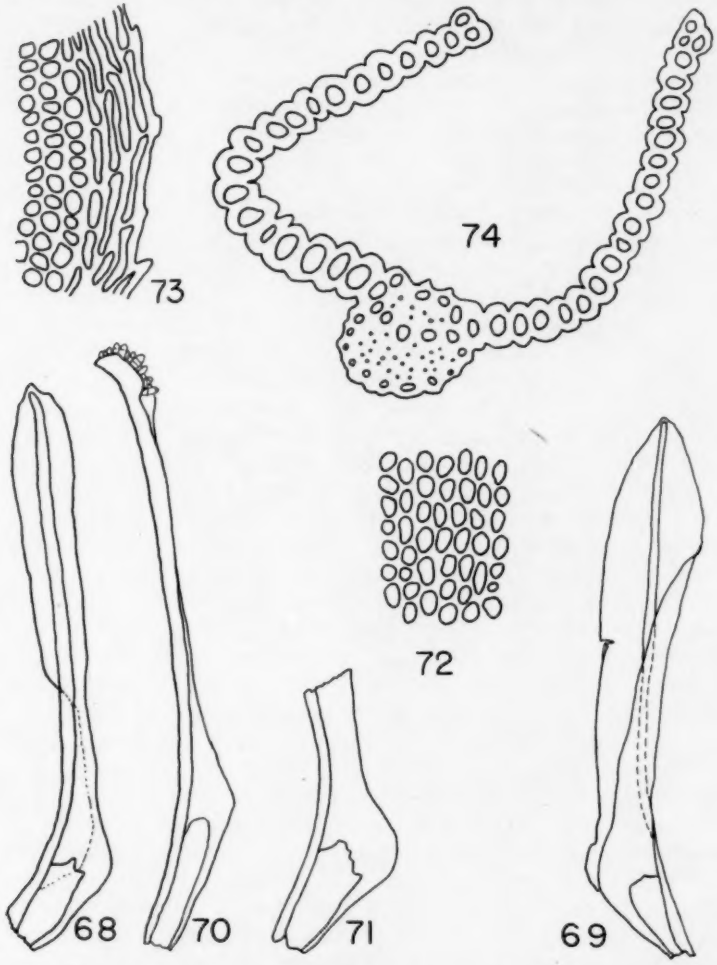

FIG. 68-74. *Calymperes smithii*. 68-69. Leaves, × 22. 70. Propaguliferous leaf, × 22. 71. Leaf base, × 22. 72. Cells at midleaf, × 320. 73. Margin and teniola at shoulder, × 320. 74. Cross-section of leaf, × 320. (All figures from type.)

Creek (Essequibo tributary), dense forest, on tree trunk, alt. 600-800 m., Jan. 19, 1938, *A. C. Smith* 2985 (NY, isotypes at K, FH, BART).

Calymperes smithii, known only from the type collection, is a very distinct species and is not likely to be confused with any others. Its distinctive features include the flaring shoulders of the lower lamina bordered by the narrow, well-defined teniolae and the fact that the cells of the upper lamina are bulging but not papillose on both surfaces. In *C. lanceolatum*, which also has bulging, non-papillose leaf cells, the basal, marginal teniolae are much broader, up to 14 cells wide; in addition the upper lamina is linear-lanceolate rather than oblong-elliptic, as in *C. smithii*.

12. C. DONNELLII Aust., Bot. Gaz. 4: 151. 1879. *C. chlorosum* Hampe, Vid. Medd. Naturh. For. Kjöbenh. 4, 1: 78. 1879. *C. brittoniae* Besch., Ann. Sci. Nat. 8, 1: 278. 1895. *C. rufescens* Besch., Ann. Sci. Nat. 8, 1: 302. 1895. *C. lindmanii* Broth., Bih. K. Svensk. Vet. Ak. Foerh. 26, 3(7): 15. 1900. *C. portoricense* Ren. & Card., Bull. Soc. Bot. Belg. 41: 57. 1902. *C. guianense* Par. & Broth., Rev. Bryol. 33: 35. 1906. *C. huallagense* Broth., Hedwigia 45: 270. 1906. *C. remirense* Par. & Broth., Rev. Bryol. 33: 36. 1906. *C. reyi* Par. & Broth., Rev. Bryol. 33: 36. 1906. Plants yellow-green to dark green when collected, drying to light green or dirty yellow in the herbarium, 3-10(-30) mm. tall; leaves strongly involute when dry, usually spreading to widely spreading and falcate to ± strongly contorted, erect-spreading when wet and usually bent outward at the junction of the upper and lower laminae, 3-5 mm. long and 0.6-1 mm. wide at the broadest point, often producing filiform propagula at the apex on the ventral surface of the costa, the clasping bases usually conspicuous because of the whitish, exposed cancellinae; upper lamina ligulate to linear-lanceolate, the apex often abruptly pinched off and forming shoulders, greatly reduced in some propaguliferous leaves, often continuous and revolute around the tip of the protruding costa; lower lamina usually sheathing, oblong to obovate in outline, nearly filled by the cancellinae; cancellinae terminating in acute angles above, 1-1.8 mm. long and ca. 1/3 the length of the leaf, composed of rectangular cells in about 10-14 rows, the apical cells smooth on both dorsal and ventral surfaces; costa ending a few cells below the apex in the lower leaves, nearly percurrent to long-excurrent in the upper, 70-85 μ wide at the apex of the cancellinae, varying from smooth to spiny-papillose dorsally and ventrally on different leaves of the same plant, in cross-section showing about 6 guide cells and with stereid bands above and below, the outer cells differentiated dorsally and ventrally; cells at midleaf obscure, (2-)5-6(-8) μ in di-

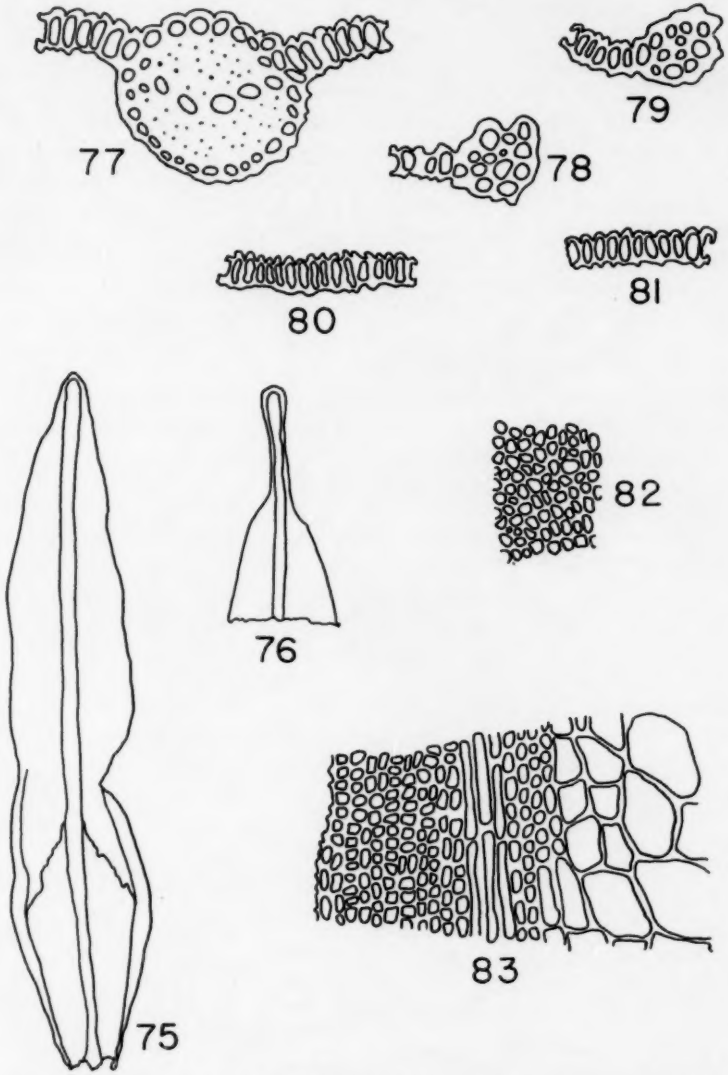

FIG. 75-83. *Calymperes donnellii*. 75. Leaf, × 23. 76. Apex of propaguliferous leaf, × 23. 77. Cross-section of costa, × 380. 78-79. Cross-sections of leaf margin, × 380. 80-81. Cross-sections of leaf cells, × 380. 82. Cells at midleaf, × 380. 83. Detail at leaf shoulder, × 380. (Fig. 75 from *W. C. Steere* 4962, Puerto Rico. Fig. 76-82 from *H. A. Crum* 623, Mexico. Fig. 83 from type.)

ameter, minutely papillose dorsally and mammillose or mammillose-papillose ventrally, variable in shape, from round or rarely oval to square or rectangular, mostly with rather thick walls, in some leaves all ca. 8 μ in diameter; teniolae 2-3 cells wide, conspicuous, running inside the margins from the insertion 1/3-1/2 the length of the leaf, (5-)9(-16) cells inside the margin at the shoulders of the leaf; leaf margin thickened from the apex of the cancellinae upward almost to the leaf apex, coarsely doubly serrate above, finely serrate below by papillose-projecting cell angles; perichaetial leaves few, smaller than the stem leaves, the cancellinae relatively larger and less distinctly separated from the upper lamina. Capsule 2-2.5 mm. long, with a few stomata at the base, cylindric, the exothecial cells thin-walled, oblong to rectangular, somewhat sinuose; operculum long-rostrate from a flattened base ca. 0.5 mm. wide, the beak ca. 0.75 mm. long; seta dark red, 4.5-5 mm. long; calyptra 4 mm. long, deeply plicate, smooth or minutely roughened above; spores 19-23 μ in diameter, finely papillose. (*Fig.* 75-83.)

TYPE: Florida: Caloosa, 1878, *J. D. Smith* & *C. F. Austin* (NY). The original material has been much divided and apparently had some plants of *C. richardii* and of *Syrrhopodon parasiticus* mixed with it. A lectotype has been annotated by me with the word type.

Calymperes donnellii is a fairly common and well-marked species and shows but little variation throughout its range. It can be confused with no other American species except perhaps with *C. erosum*, from which it may be distinguished by the mammillose apical cells of the cancellinae of the latter. In addition, the margin of *C. erosum* is unistratose except for a short distance in the sub-apical region, whereas in *C. donnellii* the margin is thickened from about the region of the apex of the cancellinae to just below the leaf apex. Cell size, which has been emphasized by previous authors as a criterion for distinguishing this species, is not always reliable. Many plants do bear leaves with the cells mostly in the size range of 4-5 μ, but some plants occur in which the leaf cells are all or nearly all in the size range of 6-8 μ.

The type collections of the following names have been examined and found not to differ in any significant way from typical *C. donnellii*: *C. chlorosum* Hampe (BRAZIL: Rio de Janeiro, *Glaziou* 9229, S-PA, isotypes at K, NY, PC, REN), *C. brittoniae* Besch. (FLORIDA: Fort Meade, Polk Co., March 1880, *J. D. Smith*, NY), *C. rufescens* Besch. (ANTILLES: Sur l'écorce du *Quassia officinalis, Richard*, NY, isotypes at K, S-PA), *C. lindmanii* Broth. (BRAZIL: Matto Grosso, Palmeiras, ad saxa, 16/12, 1893, *C. A. M. Lindman* 409, S-PA, isotype at H), *C. portoricense* Ren. & Card. (PUERTO RICO: Wet woods E. of Santurce, on tree trunks, 19

Jan. 1900, *A. Heller* 4331, NY), *C. guianense* Par. & Broth. (GUIANA GALLICA: Macouria, in ditione Cayenneni, ad Sapotaceam, 16/X/1904, *Galliot*, H), *C. huallagense* Broth. (PERU: Río Huallaga, auf Felsen im Walde des Cumbasso, 600 m., Feb. 1903, *E. Ule* 2363, H, isotypes at FH, PC, S-PA, MG, M, K), *C. remirense* Par. & Broth. (GUIANA GALLICA: Mont-Joly, ad Genipam, 22/X-1906, *Galliot*, REN, isotype at H), *C. reyi* Par. & Broth. (GUIANA GALLICA: Macouria, ad Sapotaceam, 16/X-1906, *Galliot*, REN). *C. donnellii*, as is the case with *C. richardii*, is an example of a rather widely distributed species which has become encumbered with synonyms. The species is so well defined and shows so little variation that one wonders how the synonomy could accumulate to such an extent. There is some confusion as to the type specimens for two of Paris and Brotherus' new species, *C. guianense* and *C. reyi*, since no specimens could be found bearing exactly the same information as cited in the original descriptions. The specimens cited above for these two names are lectotypes and were selected from material seen and named by either Paris or Brotherus, or both. The lectotype for *C. guianense* is in Brotherus' herbarium at Helsinki and bears the name "*C. guianense* Broth. & Par.," although the name was published with the authors' names in reverse order; there was no specimen under this name in Paris' herbarium at Rennes. The lectotype for *C. reyi* is in Paris' herbarium and bears the name "*C. reyi* Par."; the name was published with Brotherus as co-author.

DISTRIBUTION: Caespitose to gregarious, or occurring as scattered, single plants, mostly on bark but also on dead wood, soil, and rock. *C. donnellii* is primarily a species of low altitudes, occupying coastal forests or similar regions, including the hammocks of southern Florida; it has also been collected from a number of localities at altitudes up to 700 m.

This species is of general occurrence around the Caribbean area. It reaches its northern limit in the west at about 19° N. Lat., in the states of Jalisco, Puebla, and Veracruz in Mexico, but is apparently absent, or at least has not yet been discovered, in the lowlands of the Isthmus of Tehuantepec and in Yucatán. It occurs in British Honduras and Guatemala, and then again in Nicaragua, Costa Rica, and in and around the Canal Zone. It is known also from Cocos island, about 300 miles to the southwest of Costa Rica. In the eastern part of its range *C. donnellii* reaches its northern limit in Citrus County, Florida, between 28 and 29° N. Lat. It is a fairly common species in southern Florida (exclusive of the Keys where it is unknown). The species is not known from the Bahamas but occurs in Cuba (mainly in the central and eastern parts), Jamaica, Haiti, and in abundance in Puerto Rico, including Mona Island. In the Leeward and Windward Islands the species has been discovered on St. Eustatius, Guadeloupe, Dominica, Martinique, St. Lucia, and Trinidad. In South America *C. donnellii*, although only sparingly collected, ranges widely from eastern Peru and Ecuador to central Venezuela and across the Guianas. The Amazon basin seems to be devoid of *C. donnellii;* nor has it been collected along the coast of Brazil between

French Guiana and Rio de Janeiro, where the southern limit of the known range of the species is reached.

13. C. EROSUM C. M., Linnaea 21: 182. 1848. *C. wullschlaegelii* Lor., Moosstud. 160. 1864. *C. melinoni* C. M. *in* Besch., Ann. Sci. Nat. 8, 1: 292. 1895. *C. sprucei* Besch., Ann. Sci. Nat. 8, 1: 304. 1895. *C. emersum* C. M., Bull. Herb. Boiss. 5: 189. 1897. *C. bodenii* C. M., Hedwigia 39: 262. 1900. *C. mammilliferum* Crum & Steere, Bryol. 59: 248. 1956. Plants light green when collected, drying in the herbarium to yellow-green or brownish, sometimes tinged below with pink or purple, 5-12(-30) mm. tall; upper lamina tightly involute and falcate when dry, the sheathing base remaining appressed to the stem and very conspicuous because of the highly refractive cancellinae; leaves widely spreading when moist, or erect-spreading, often remaining somewhat involute, extremely variable, mostly 3-4.5 mm. long and ca. 0.5-1.5 mm. wide; some leaves (or occasionally all) bearing filiform-clavate propagula on all sides of the costa at the apex; upper lamina ligulate to ligulate-lanceolate or, in some highly modified, propaguliferous leaves greatly reduced and confined to relatively small areas between the apices of the cancellinae and the stout, long-excurrent costa, often bent outward at an angle of ca. 45° at the junction of the upper and lower laminae; lower lamina obovate in outline, comprising from 1/3-1/2 the length of the leaf; apices of non-propaguliferous leaves often abruptly pinched off, forming a characteristic, shouldered leaf tip with the costa ending a few cells below the apex; cancellinae acute or irregularly rounded above, the apical cells mammillose, often highly so, on the ventral surface; costa (40-)75 (-100) μ wide at the apex of the cancellinae, smooth dorsally except near the apex, or occasionally, in propaguliferous leaves, slightly papillose to below the shoulders, the ventral surface usually ± heavily mammillose-papillose from the apex to just below the leaf shoulders; cross-section showing about 6 median guide cells with stereid bands above and below, the outer cells differentiated on both sides, occasionally with 2 rows of cells differentiated on the ventral surface; cells of the upper lamina mammillose-papillose ventrally and finely papillose dorsally, extremely variable as to size and shape, at midleaf on non-propaguliferous leaves from irregularly rounded to square or rectangular, mostly 5-7 × 7-10 μ; occasional plants having all the leaves except a few of the lower ones bearing considerably larger and more pellucid cells, up to 8 × 17 μ; teniolae usually prominent and well developed from the leaf base to near the apex, rarely absent from the lower part of the leaf below the apex of the cancellinae, 2-3 cells wide and in

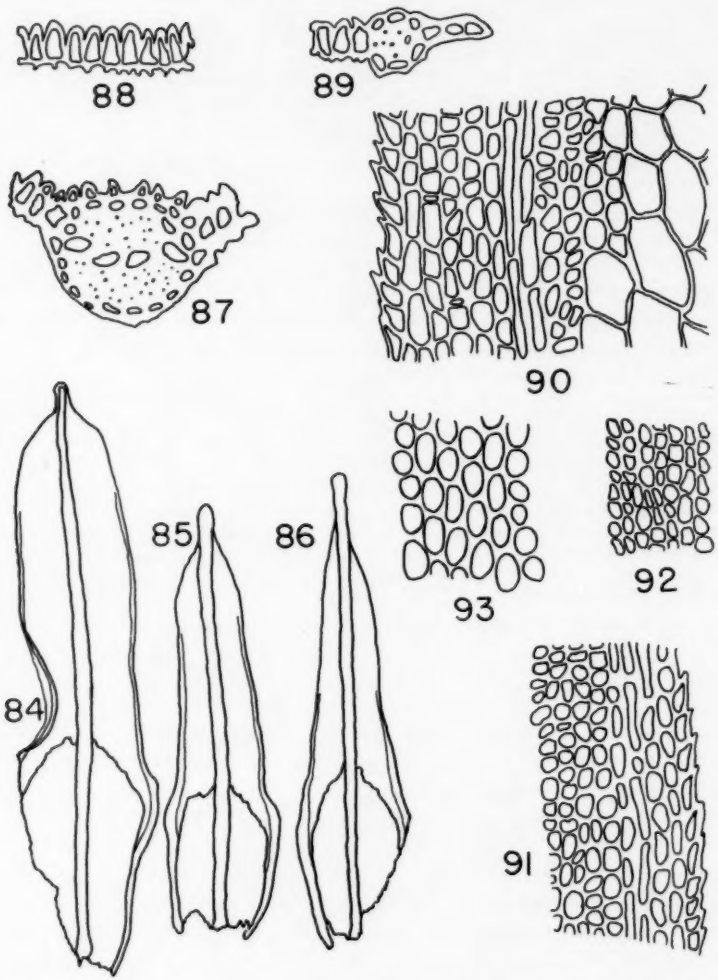

FIG. 84-93. *Calymperes erosum*. 84. Lower leaf, × 23. 85. Median leaf, × 23. 86. Upper leaf, × 23. 87. Cross-section of costa, × 380. 88. Cross-section of leaf cells, × 380. 89. Cross-section of margin, × 380. 90. Detail at leaf shoulder, × 380. 91. Margin and cells at midleaf, × 380. 92. Cells at midleaf, lower leaf, × 380. 93. Cells at midleaf, upper leaf, × 380. (Fig. 84 from A. J. Grout, *N. Am. Musci Perf.* 322, Florida. Fig. 85 and 92-93 from *N. W. Simmonds* 345a, Trinidad. Fig. 86 from *N. W. Simmonds* 350a, Trinidad. Fig. 87-89 and 91 from *Bernoulli & Cario* 134, Guatemala. Fig. 90 from *A. J. Grout*, 22 March 1934, Hattie Bauer Hammock, Dade Co., Florida.)

cross-section consisting of a few stereids surrounded by a layer of larger cells, from 2-8 cells in from the margin at the shoulders and continuing, 2-3 cells inside the margin, nearly to the leaf apex, or often forming a thickened border on the upper leaf margins for a short distance below the apex; margins finely serrate all around, except in the basal part, by papillose-protruding cell angles, usually serrate-dentate for a short distance below the apex; perichaetial leaves shorter than the stem leaves, the cancellinae less distinct and relatively larger, the teniolae interrupted and weak. Sporophytes rarely produced. Capsule cylindric, with a few stomata at the base, ca. 2.5 mm. long, the exothecial cells oblong, sinuous, thin-walled; operculum short-conic, the beak ca. 0.8 mm. long; seta ca. 4.5 mm. long; calyptra strongly plicate, finely papillose toward the apex, ca. 4.5 mm. long; spores finely but densely papillose, 20-26 μ in diameter. (*Fig.* 84-93.)

TYPE: Surinam: Guiane-hollandaise, prope fl. Tou . . . (partly illegible), *Kegel* 539 (PC). In the original description Müller cited two specimens. The first, cited above, may be designated the lectotype; the second (SURINAM: 1845, 12/XII, *Miquel*, NY) represents a different species altogether, *C. uleanum* Broth. Müller's comments accompanying the original description of *C. erosum* imply that the description of the sporophyte was drawn from Miquel's specimen rather than from that of Kegel, and the description should be emended so as to exclude reference to the sporophyte.

In spite of the great variability in size and shape of the cells and in the shape of the leaves, which may vary on a single plant from broad and non-propaguliferous at the base of the stem, to narrow, attenuated, highly modified, and propaguliferous near the stem tip, this species is very distinct and quite easy to recognize. The papillose cells, the pinched-off and serrate-dentate apex of the non-propaguliferous leaves, the teniolae running inside the plane, unistratose (below) margins nearly to the leaf apex, and the mammillose cells of the apical part of the cancellinae are all good characters. This species is likely to be confused only with *C. donnellii* and *C. uleanum*.

It may be distinguished from the former by the larger and more irregular leaf cells, the teniolae extending nearly to the leaf apex and the mammillose apical cells of the cancellinae. From the latter *C. erosum* may be distinguished by having the cancellinae acute or irregularly rounded above and the costa less papillose and in cross-section showing definite bands of stereid cells.

The type specimens for the following names have been examined and found to differ in no significant way from typical *C. erosum*. In some cases in which the identity of the original collection was in doubt, lectotypes have been designated. *C. wullschlaegelii* Lor.

(SURINAM: Paramaribo, *Wullschlaegel*, NY, lectotype, isotype at BM), *C. melinoni* C. M. *in* Besch. (FRENCH GUIANA: *Melinon*, NY, lectotype), *C. sprucei* Besch. (SOUTH AMERICA: Amazon, *Spruce* 20, PC), *C. emersum* C. M. (GUATEMALA; Mazatenango, *Bernoulli & Cario* 134, NY), *C. bodenii* C. M. (BRAZIL: Bahia, *Boden*, NY, isotype at H), *C. mammilliferum* Crum & Steere (PUERTO RICO: On wet lower surface of overhanging rock, south of Yabucoa, km. 102.9 on road to Maunabo, 20 Nov. 1939, *W. C. Steere* 4965, MICH).

DISTRIBUTION: In cushions, small clumps, or as single plants, mostly on bark and stumps or logs, but also on rock and soil. It seems to be a species of rather mesic forests and hammocks, occurring most commonly at altitudes above 50 m. and up to about 650 m.

This is a species of wide, although rather sparse occurrence around the Caribbean area, reaching its northern limit in the west in British Honduras. It has been reported incorrectly from Mexico but there seems to be no reason why it should not be discovered there eventually. Single collections are known from Guatemala (west coast), Honduras and Nicaragua, and several from the Canal Zone and Panama, the most easterly being from San José Island in the Gulf of Panama. The northern limit in the east is reached in Manatee County on the west coast of Florida, from whence the species occurs sporadically down the coast to Collier County and across the peninsula in the hammocks around Miami in Dade County. It has not been collected on the Keys. In the Greater Antilles *C. erosum* has been collected sparingly in western Cuba (including the Isle of Pines), Jamaica (2 collections), Dominican Republic (1 collection), and eastern Puerto Rico (1 collection). In the Leeward and Windward Islands it has been collected on Guadeloupe, Dominica, Martinique and St. Vincent, and also on Trinidad. Its range in South America includes scattered areas on the west coast of Colombia, central and southern Venezuela, the Guianas, and several stations in Brazil in the states of Pará, Pernambuco, and Bahia. In addition the species is known from the Galápagos Islands.

14. C. NICARAGUENSE Ren. & Card., Bull. Soc. Bot. Belg. 33: 117. 1894. *C. carionis* C. M., Bull. Herb. Boiss. 5: 189. 1897. *C. bolivianum* Williams, Bull. New York Bot. Gard. 3: 115. 1903. *C. heribaudii* Par. & Broth., Rev. Bryol. 35: 49. 1908. *C. othmeri* Herz., Arch. Bot. Est. S. Paulo 1: 60. 1923. *C. rupicola* Rich., Bull. Misc. Inf. Kew 8: 323. 1934. Plants light colored, bright green above, not much darker below, (3-)10-20(-30) mm. tall, often bearing conspicuous tufts of dark red radicles on the lower parts; leaves when dry with the upper lamina tightly involute and curved or twisted (the lower lamina conspicuous because of the broadly exposed, highly refractive cancellinae), when wet ascending to spreading, often somewhat secund, those from sterile regions of the stem (3-)4-5 (-6) mm. long and ca. 0.7-1.5 mm. wide at the shoulders; upper lamina subulate to linear or linear-lanceolate from a broader,

usually oblong or obovoid, sheathing base, the apical region often much reduced in propaguliferous leaves, the apex acute to narrowly rounded, sometimes slightly constricted below the tip and forming shoulders; leaves from fertile regions of the stem with the upper laminae as described but with the bases much broader, often flaring abruptly and forming broad shoulders in the vicinity of the upper ends of the cancellinae; upper leaves infrequently bearing small clusters of clavate propagula, 155-225 μ long, on the upper surface of the costa at the apex; cancellinae of leaves from sterile regions of the stem ending in acute angles above, or rounded, oblong or rectangular in outline and composed of ca. 11-14 rows of square to oblong cells, nearly filling the leaf base, the apical cells occasionally thick-walled and pitted, about 1/3 the length of the leaf, those of leaves from fertile parts of the stem larger and irregular above; costa stout, ending a few cells below the leaf apex or, especially in propaguliferous leaves, excurrent, ca. 60-80 μ wide near the apex of the cancellinae, papillose-roughened dorsally in the upper part, mammillose ventrally from about midleaf to the apex, the cross-section showing about 6-7 median guide cells, occasional accessory guide cells, and bands of stereids above and below, the outer cells differentiated dorsally and ventrally; cells at midleaf obscure, thick-walled, quadrate to rounded or elongated, mostly 5-8 μ in greatest dimension, highly mammillose ventrally and smooth or slightly mammillose dorsally; teniolae variable, often absent or interrupted, when present 2-4 cells wide and up to ca. 10 cells in from the margins at the leaf shoulders, the cells elongated, thick-walled, only rarely sinuose or pitted, short and confined to the upper part of the leaf base or extending downward from the lower ends of the thickened margins and disappearing in the margins of the lower part of the leaf base; margins of the leaves thickened from above the shoulders to just below the apex, serrulate all around and becoming more coarsely so toward the apex, in cross-section irregularly circular to angular and composed of large cells with 1-3 stereids occasionally present; outer perichaetial leaves broadly sheathing at the base, the inner smaller than the stem leaves, scarcely sheathing, and with the apices of the cancellinae irregularly rounded and divided. Capsule ca. 2-2.5 mm. long, without stomata, cylindric, the exothecial cells oblong and somewhat sinuate; operculum rostrate from a conic base, ca. 1 mm. long; seta 4-5 mm. long; calyptra 4-4.5 mm. long, plicate, papillose-roughened above; spores 17-30 μ in diameter, finely roughened. (*Fig.* 94-100.)

TYPE: Nicaragua: Escondido River, 50 mi. from Bluefields, 12 Nov. 1892, *C. W. Richmond* (NY, isotype at BM).

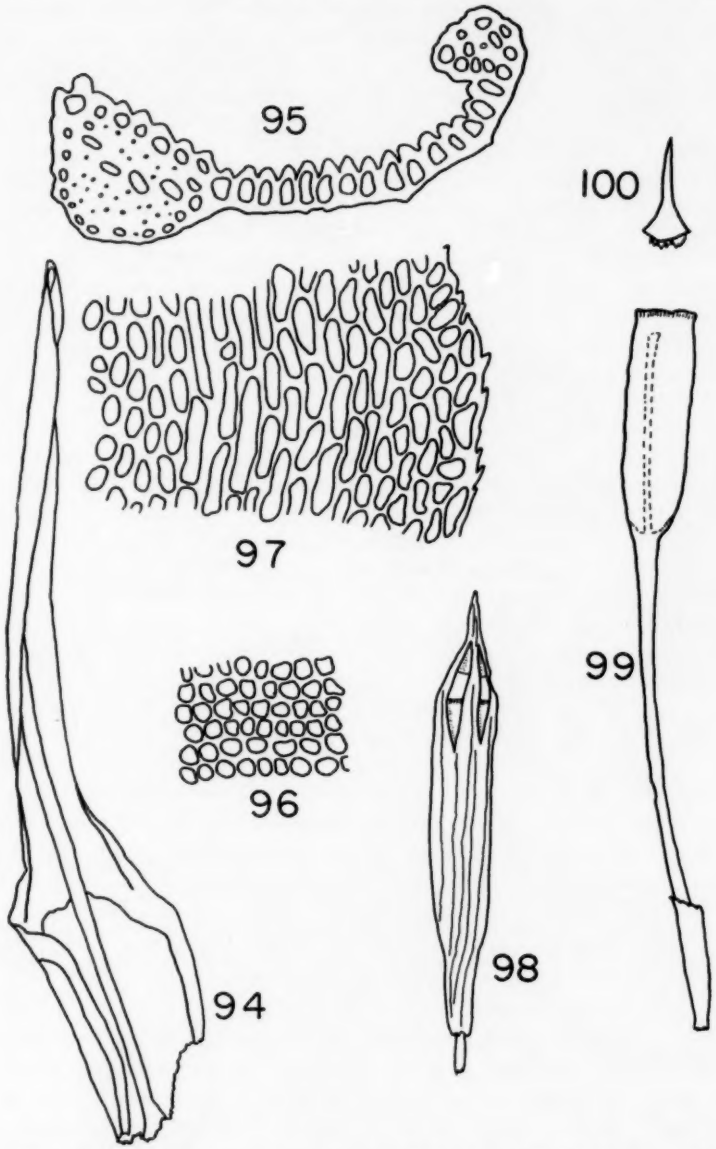

FIG. 94-100. *Calymperes nicaraguense*. 94. Leaf, × 23. 95. Cross-section of leaf, × 380. 96. Cells at midleaf, × 380. 97. Detail at leaf shoulder, × 380. 98. Capsule and operculum, both enclosed by the calyptra, × 11. 99. Capsule and seta, × 11. 100. Operculum, × 11. (Fig. 94 from *P. Gentle* 3531, British Honduras. Fig. 95-100 from type.)

C. nicaraguense is best characterized by its usually variable teniolae (from strong to absent or nearly so), by the margins of the leaves always serrulate, by the usually subulate upper lamina, and by the often flaring lower lamina having broadened shoulders.

C. nicaraguense includes the following names, the types of which I have examined: *C. carionis* C. M. (GUATEMALA: *Bernoulli & Cario* 91, NY), *C. bolivianum* Williams (BOLIVIA: Mapiri, 1700 ft., on tree trunk, 24 Sept. 1901, *R. S. Williams* 1804, NY, isotypes at H, K, MICH), *C. heribaudii* Par. & Broth. (PANAMA: Prov. de Chiriquí in silvula Boquete, pr. David, 9-1906, *Fr. Helión*, REN, isotypes at NY, M), *C. othmeri* Herz. (GUYANA: In dem Lauf der Caroni, Moos an Granitfelsen in der Höhe der . . . (partly illegible), 25/1. 07, *Herzog*(?), M), *C. rupicola* Rich. (BRITISH GUIANA: Essequibo River, first falls, on dry gneiss rocks near river, 1929, *P. W. Richards* 357, K. isotype at NY).

The variable nature of this species, owing in part perhaps to hybridization with its closest relative, *C. guildingii*, accounts for the several synonyms it has accumulated. I have seen specimens from northeastern South America, Trinidad, and St. Lucia which might be interpreted as intermediates between the two species, although in all cases the plants were quite similar to "typical" *C. nicaraguense*. In general, however, the two species are quite distinct.

The manner in which Paris and Brotherus published the name *C. heribaudii* has given rise to a certain amount of confusion since the original description appeared in the midst of an article entitled "Muscinées de l'Asie Orientale," where it was for some time overlooked by workers interested mainly in American plants. Thus Williams, in his revision of the North American Calymperaceae, cited the name as having been published in the first edition of *Die natürlichen Pflanzenfamilien*, where it appeared as a name only, and Richards (1934), who was evidently unaware of its citation by Williams, noted that the name was apparently a *nomen nudum* and also suggested that *C. heribaudii* might be conspecific with *C. rupicola*.

DISTRIBUTION: In dense cushions on bark, dead wood, or rarely on rocks, at altitudes up to 1000 m. It is apparently a species of densely forested slopes and river valleys.

In Central America the species is known from Guatemala and British Honduras to western Panama. In South America it is known from one collection from west-central Venezuela, one from southeastern Venezuela, several collections from British Guiana, one collection from northern Pará, Brazil, and from an apparently disjunct station in northern Bolivia. Several other specimens exist with no more precise locality data than "Guiana" or "Amazon." Around the Caribbean *C. nicaraguense* is known from several

collections each from Trinidad and St. Lucia, one collection from southwestern Haiti, and one from Puerto Rico. The species has not been reported from the West Indies before now and evidently is not common in the islands.

15. C. GUILDINGII Hook. & Grev., Edinb. Jour. Sci. 3: 223. 1825. *C. cruegeri* C. M., Syn. 1: 527. 1849. *Syrrhopodon badius* Schimp. *in* Besch., Ann. Sci. Nat. 6, 3: 197. 1876. *Calymperes badium* (Schimp.) Broth. *in* E. & P., Nat. Pfl. 1(3): 379. 1901. *C. guadaloupense* Broth. *in* Urb., Symb. Ant. 3: 423. 1903. Plants dark, dirty green to blackish below, light green in the upper part, mostly 20-30(-45) mm. tall; leaves, at least those at the tip of the stem, with the upper lamina tightly involute and variously curled and twisted when dry, the basal lamina tightly appressed to the stem and conspicuous by means of the refractive cells of the cancellinae, spreading to ascending when wet, occasionally some reflexed, usually with the bases remaining folded when removed from the stem and with the upper lamina bent at the shoulders, at an angle of 45° or less from the lower lamina, (4-)5-6(-7) mm. long and (0.5-)0.7-1 mm. wide at the shoulders; upper lamina subulate from an oblong or somewhat cuneate, sheathing base, the apex acute or, especially in propaguliferous leaves, blunt and narrowly rounded; lower lamina often terminating above in prominent shoulders; propagula infrequent, clavate, ca. 250 μ long, produced on the ventral surface of the upper leaves; cancellinae ca. 1/4-1/5 the length of the leaf, terminating in acute angles above or somewhat rounded and separated from the costa by small, green cells, as a whole approximately rectangular, filling the leaf base, consisting of about 11-14 rows of square or oblong cells which become smaller and more elongated toward the margins, the apical cells usually with rather thick and heavily pitted walls; costa stout, (50-)60-80(-100) μ wide at the leaf shoulders, smooth dorsally and ventrally except near the apex, ending a few cells below the apex or short-excurrent or, especially in propaguliferous leaves, excurrent as a slightly roughened knob, in cross-section showing a median row of 6-8 guide cells with stereids above and below and with the outer cells differentiated dorsally and ventrally; cells at midleaf square to elliptic or rectangular, thick-walled, (5-)7-14(-17) μ long and ca. 7-9 μ wide, variable, in some leaves all much larger than in other leaves from the same plant, smooth dorsally and highly mammillose to mammillose-papillose ventrally; teniolae 4-6 cells wide at the leaf shoulders and 4-8 cells in from the margins, composed at the leaf shoulders of elongated, thick-walled cells with the walls ± heavily pitted and somewhat sinuose, the cells between the teniolae and the margins often of a similar nature, merging with the thickened leaf border above the shoulders and vanishing

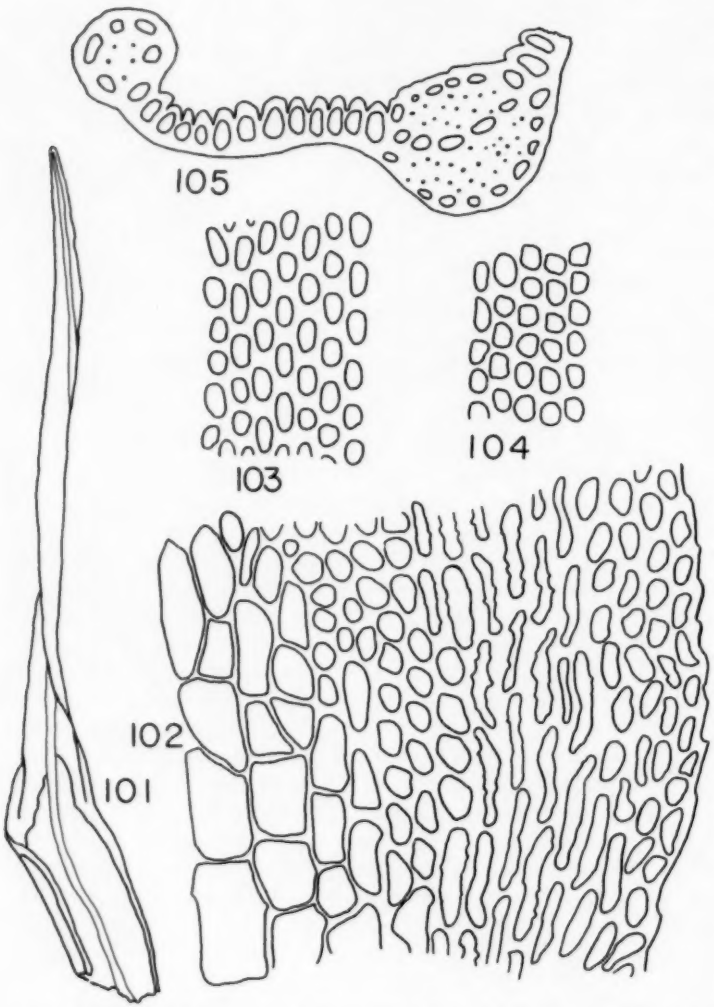

FIG. 101-105. *Calymperes guildingii*. 101. Leaf, × 23. 102. Detail at leaf shoulder, × 380. 103-104. Cells at midleaf, × 380. 105. Cross-section of leaf, × 380. (Fig. 101 from *H. H. Smith* 1455, St. Vincent. Fig. 102 and 104 from type. Fig. 103 from *W. C. Steere* 4079, Puerto Rico. Fig. 105 from Husnot *Pl des Antilles* 135, Guadeloupe.)

along the margins of the cancellinae in the leaf base, occasionally less well developed and confined to the upper part of the leaf base or almost obsolete; leaf margins from the shoulders to the apex entire except for scattered teeth, below the shoulders serrate or more often entire, usually greatly thickened from just above the shoulders to just below the apex, in cross-section showing a group of stereids surrounded by a ring of larger cells; perichaetial leaves with less prominent shoulders, the cancellinae more extensive, less sharply defined, and composed of smaller cells with thick, usually pitted walls. Capsule cylindric, without stomata, ca. 2.3 mm. long, the exothecial cells rectangular, rather thin-walled; operculum ca. 1 mm. long, rostrate from a conic base; seta ca. 3-4 mm. long; calyptra 4-5 mm. long, plicate, slightly roughened above; spores mostly 24-35 μ in diameter, finely roughened. (*Fig.* 101-105).

TYPE: St. Vincent, B. W. I.: Habitatis frequens in opacis montis St. Andrews, corticem aborum . . . (partly illegible), *Guilding* (K).

Calymperes guildingii is a well-defined species and is likely to be confused only with *C. nicaraguense*. The distinctive nature of the teniolae at the leaf shoulders, together with the fact that the margins of the upper lamina are entire except for scattered teeth, serves amply to distinguish *C. guildingii*. It is probable that where their ranges overlap, *viz.*, in the West Indies and northern South America, *C. guildingii* intergrades to some extent with *C. nicaraguense*.

The type collection of *C. cruegeri* C. M. (TRINIDAD: Monte Tocuche, 4 Dec. 1847, *Crüger,* NY) has been examined and found to be identical to typical *C. guildingii*. In the original description of *C. cruegeri* Müller stated that the leaf margins were entire, but as Bescherelle (1896) pointed out (even though he retained the species as distinct), the leaf margins of the type are more or less distantly toothed. This is also true of the type of *C. guildingii*, contrary to a statement in the original description. The type collections of *Syrrhopodon badius* Schimp. (GUADELOUPE: Vallée de Saint Louis, sur la terre, 1868, Husnot, *Pl. des Antilles* 195, NY) and *Calymperes guadeloupense* Broth. (GUADELOUPE: Morne Hirondelle, ad truncos arborum, 1901, *Duss* 241, NY, isotype at H) have been studied. Neither differs significantly from typical *C. guildingii*.

DISTRIBUTION: Growing in dense, stiff clumps, mostly on rock but also on soil, bark, and dead wood. It has been collected from as high as 1200 m. but seems to be most common between 500 and 800 m. Although the species occupies varied habitats it probably occurs most commonly on rather moist mountain slopes.

This species is almost entirely restricted to the eastern rim of the Caribbean where it occurs in some abundance on the eastern end of Puerto Rico, then west to St. Kitts and south through Guadeloupe, Dominica, Martinique, St. Lucia, St. Vincent, and Trinidad. Two departures from this distributional pattern include several collections from the eastern end of Jamaica and a single collection from Tafelberg, Surinam. It seems reasonable to expect that the species will be found, eventually, in the mountains of eastern Cuba and in Hispaniola and to be more widespread in the Guyana Highlands of South America.

16. **C. bartramii** n. sp.[3] Dry plants light- or olive-green in the upper part, brown or blackish below and bearing tufts of reddish-brown radicals in the leaf axils; mostly 6(-9) mm. long; leaves strongly inrolled and contorted in the upper 3/4 when dry, widely spreading and curved upward and remaining involute when wet, (4-)4.5-5(-5.5) mm. long, up to 1 mm. wide at the shoulders of the lower lamina; upper lamina subulate and involute, arising abruptly from the broadly obovate, often flaring, less strongly involute lower lamina; propagula scarce, produced on the ventral surface of the costa at the apex of the leaf, smooth, clavate, with 7-9 cross-walls, ca. 250 μ long, frequently lodging and germinating on the channeled, ventral surface of the leaf; cancellinae gradually rounded or occasionally truncate above, obovate in outline, filling about 2/3 of the width of the lower lamina, ending below the shoulders; costa percurrent, (40-)50-60(-70) μ wide at the apex of the cancellinae, smooth or nearly so dorsally, roughened ventrally in the upper part by mammillose cells, the cross-section with a median row of 4-6 guide cells and with bands of stereids above and below the guide cells, the outer cells differentiated dorsally and ventrally; cells at midleaf with very thick walls and oval lumina, rounded, or more commonly vertically elongated, (8-)10-12(-13) μ long by 6.5-8.5 μ wide, smooth dorsally, merely bulging to highly mammillose ventrally; teniolae usually distinct and intramarginal

[3] Plantae siccae in superiore virides, in inferiore brunnae vel nigrescentes, saepe 6(-9) mm. altitudine; folia sicca valida involuta et contorta in superiore 3/4, late patentia et arcuata scandentia; tamen madentia involuta, (4-)4.5-5(-5.5) mm. longitudine, usque ad 1 mm. lata prope umeros; lamina superiore subulata, valide involuta; lamina inferior late obovata, minus valide involuta; propagula infrequentissima, in apice costae in ventro, levia, clavata, cum 7-9 cellulis, ca. 250 μ longitudine; cancellinae obovatae, finientes sub umeris folii, in pars superior gradatim rotundatae aut truncatae; costa percurrente, (40-)50-60(-70) μ latitudine prope apices cancellinarum, in dorso paene levis, in ventro cum cellulis mammillosis, in sectio cum 4-6 majoribus cellulis in medio et cum cellulis stereidibus in superiore et in inferiore; cellulae folii in medio cum parietibus densis et cum luminibus minutis, leves in dorso et in ventro vix aut maxime mammillosae; teniolae in parte superiore distinctae, intramarginales, in parte inferiore marginales et latissimae; margines laminae superioris integri, involuti, unistrati in parte superiore, multistrati in parte inferiore; margines laminae inferioris unistrati, serrulati vel serrati. Fructus ignotus.

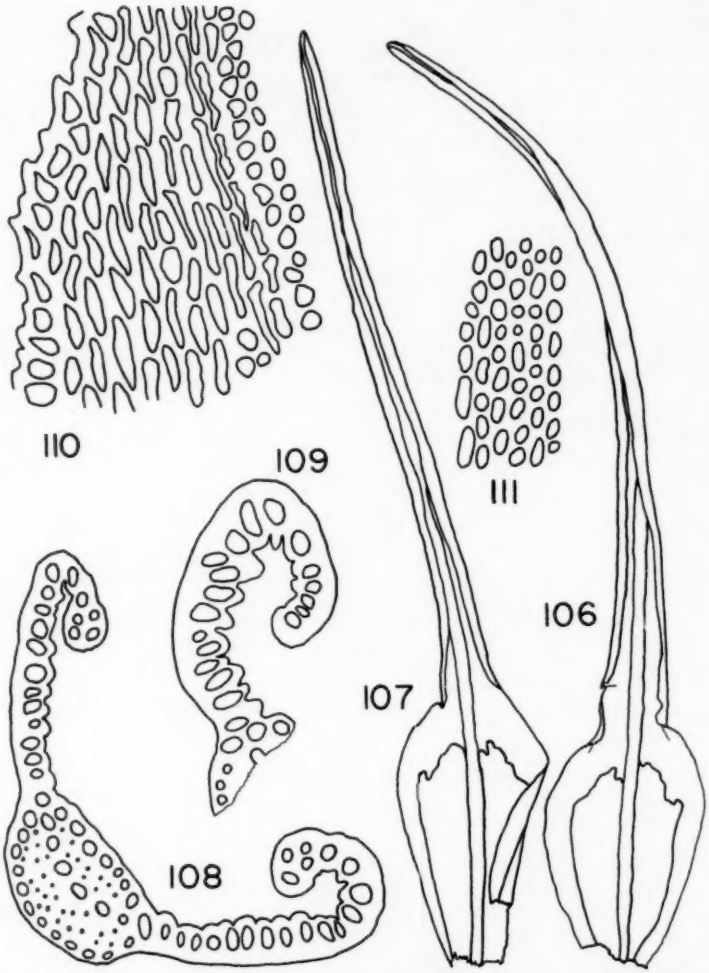

FIG. 106-111. *Calymperes bartramii*. 106-107. Leaves, × 22. 108-109. Cross-sections of leaf, × 320. 110. Margin and teniola at shoulder, × 320. 111. Cells at midleaf, × 320. (All figures from type.)

at the bases of the thickened margins of the upper lamina above the leaf shoulders, becoming very broad and extending to the margins of the lower lamina below the leaf shoulders, composed of elongated cells (often with pointed ends), with thickened, often pitted and irregular walls; margin of the upper lamina entire,

mostly strongly infolded from the apex to just above the leaf shoulders, unistratose in the upper part, the lower part thickened and showing in cross-section a group of 3-6 thick-walled cells which occasionally enclose 1-2 stereids, the margin of the lower lamina unistratose, sharply serrate or serrulate by projecting cell angles. Sporophyte unknown. (*Fig.* 106-111.)

TYPE: Colombia: On trunks, ca. 250 m. alt., Cachivera Palito, Río Kananari, Vaupés, July 28, 1951, *R. E. Schultes* & *Isidoro Cabrera* 13199 (CAN, isotype BART). PARATYPE: Venezuela: Estado Bolivar, rich forest, vicinity of base camp, near Río Tirica, lower southwestern slopes of Chimanta-tepui (Torovo-tepui), alt. 1000 m. on living tree trunk, May 24, 1953, *Julian A. Steyermark* 75543 (BART, NY, F).

This is a very distinctive species and is named in honor of Edwin B. Bartram, who originally called it to my attention and who very kindly provided the specimens which I have examined. The species can serve in some degree as a tribute to the great service to bryology which Mr. Bartram has performed through his many notable contributions to the science. *C. bartramii* is easily recognized and is distinct from all other American *Calymperes* by its subulate, involute upper lamina with the margins inrolled. Its closest relates seem to be *C. guildingii* and *C. nicaraguense*.

EXCLUDED SPECIES

C. armatum Broth., Denkschr. Ak. Wiss. Wien, Math.-Nat. Kl. 83: 282. 1926. The type collection (BRAZIL: São Paulo, pr. Rio Grande, ad arb. in silva primig., 800 m.s.m., 7/6/1901, *Schiffner* 883, H) and the paratype (BRAZIL: São Paulo, in vicinitate sanatorii "Guaruja" propre Santos, in silva ad arbores, 1-50 m.s.m., 15/5/1901, *V. Schiffner* 910, H) have been examined. Both specimens are *Syrrhopodon incompletus* Schwaegr.

C. disciforme C. M., Linnaea 21: 183. 1848. This name has been long subject to confusion and misapplication both in American and European herbaria. The species was originally described from Surinam and from the original description is closely related to or identical with *Syrrhopodon parasiticus* (Sw.) Besch. I have found packets bearing the name *C. disciforme* to contain at least the following species: *C. donnellii, C. erosum, C. richardii,* and *Syrrhopodon parasiticus*. In European herbaria the greater number of the collections labeled *C. disciforme* were found to contain *C. richardii,* whereas in American herbaria, following Williams revision of the genus *Calymperes* in 1920, the name has been applied to a narrow-leaved segregate of *C. erosum*. The type collection of *C. disciforme* is presumed to have been destroyed in Berlin during World War II, but from notes and letters at the New York Botanical Garden it seems that Elizabeth G. Britton and R. S. Williams had opportunity to examine a single leaf from Berlin that was purported to be from the type. The cross-section of a leaf which Williams illustrated as *C. disciforme* in his revision seems most likely to have come from the shoulder region of a leaf of *C. richardii*. Crum and Steere (1957) placed *C. disciforme* in the synonomy of *Syrrhopodon parasiticus*.

C. fluviatile Williams, Bull. Torrey Bot. Club 47: 394. 1920. This species has no true affinities with *Calymperes* and has been assigned to a new genus, *Teniola* (Reese, 1960).

C. glaziovii Hampe, Vid. Medd. Naturh. For. Kjöbenh. 3, 9-10: 252. 1877. The type collection (BRAZIL: In viciniis Rio de Janeiro, 1876, *Glaziou* 7449, S-PA, isotype G) has been examined. It is *Syrrhopodon incompletus* Schwaegr.

C. leboucherianum Par. & Broth., Rev. Bryol. 33: 36. 1906. The type collection (FRENCH GUIANA: Mtgne. des Pères, ad Palman Maripa dictam, 16/X-1906, *Galliot*, REN), has been examined. A fruiting plant was found (evidently overlooked by Paris and Brotherus) which, since the capsule is not enclosed by a persistent calyptra and does possess a peristome, proves this species to belong to the genus *Syrrhopodon*. The correct name is **Syrrhopodon leboucherianum** (Par. & Broth.) n. comb.

C. semilimbatum C. M., Hedwigia 39: 261. 1900. The type collection (BRAZIL: Novo-Friburgum, *Peters*, NY) has been examined. It is *Syrrhopodon parasiticus* (Sw.) Besch.

NOMINA NUDA

The following are *nomina nuda* which have been applied to American *Calymperes* in the literature. The list does not include those which have been published correctly in the *Index Muscorum*, vol. 1, 1959.

C. crenulatum, *in* Besch., Ann. Sci. Nat. 8, 1: 307. 1896.

C. damazii Broth. *in* Wijk, Marg. & Flor., Index Muscorum 1: 405. 1959. This name is an error for *Campylopus damazii* Broth., Denkschr. Ak. Wiss. Wien, Math. Nat. Kl. 83: 260. 1926.

C. galliotii Broth. & Par. *in* Reese, Bryol. 60: 336. 1957.

C. lekyanum Besch. *in* Roth, Hedwigia 51: 133. 1912. This name is an error for *C. levyanum* Besch.

C. mirabile Broth. *in* A. Weberbauer, El mundo vegetal de los Andes Peruanos. p. 611. 1945. Lima.

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SWARTZ, O. 1813. *Calymperes. In* Weber, Tabula Exhibens Calyptratarum Operculatarum Muscorum Frondosorum Genera. C. P. Mohr, Kiliae.
WIJK, R. VAN DER, W. D. MARGADANT, & P. A. FLORSCHÜTZ. 1959. Index Muscorum. Vol. 1, A-C. Regnum Veget. 17: 1-548.
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A REVISION OF THE GENUS RHABDOWEISIA[1]

ELVA LAWTON[2]

The genus *Rhabdoweisia* was established in 1846 by Bruch, Schimper, and Gümbel for three species of small mosses which had previously been included in *Bryum, Weissia,* or *Grimmia.* These mosses are now known as *Rhabdoweisia fugax, R. denticulata,* and *Cnestrum schisti.* The new genus was composed of species from Bridel's (1826) *Weissia,* the section with crisped leaves and branched stems, and was given the name *Rhabdoweisia,* which means a fluted column and refers to an important distinguishing character, the ribbed capsule. While *Cnestrum schisti* resembles the other species in general appearance, it differs in having strongly mammillose leaf cells and longitudinally striate peristome teeth and, therefore, has not been included in the genus by later authors.

Lindberg (1879) included the species of *Rhabdoweisia* in the genus *Oncophorus,* but they deserve generic rank because they form a natural group and differ in a number of ways from *Oncophorus.* The capsules are never strumose and are always erect and symmetric; the peristome teeth are undivided and are not longitudinally striate; the leaf cells are not papillose; the leaf margins are always unistratose and either plane or slightly recurved for only a short distance.

Brotherus (1924) listed six species of *Rhabdoweisia* and four species and several varieties and forms have been described later. Of the ten specific names, four are synonyms and two are species

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which belong to other genera and not to *Rhabdoweisia*. The remaining four species constitute the genus as defined below. Types of a majority of the taxa studied have been available.

The following abbreviations designate the location of the specimens cited below, and the writer wishes to thank all institutions and individuals for material which was lent and Dr. A. C. Crundwell, who supplied specimens from the British Isles. BARTRAM, E. B. Bartram, Bushkill, Pa. BR, Jardin Botanique de l'Etat, Bruxelles. H, Botanical Museum, Helsinki. LAU Musée Botanique Cantonal, Lausanne. NOGUCHI, Kumamoto University, Kumamoto. NY, New York Botanical Garden. PC, Muséum National d'Histoire Naturelle, Laboratoire de Cryptogamie, Paris. S-PA, Naturhistoriska Riksmuseum, Paleobotanical Dept., Stockholm 50. TENN, University of Tennessee. UPS, Institute of Systematic Botany, University of Uppsala. W, Naturhistorisches Museum, Wien. WTU, University of Washington, Seattle. ZT, Institut für spezielle Botanik, Eidg. Technischen Hochschule, Zürich.

RHABDOWEISIA BSG, Bryol. Eur. fasc. 33-36. 1846.

Small plants 0.2-3 cm. high, in dense tufts or cushions, green above and brown below; stems without central strand, bearing short branches and rhizoids below; leaves 1.5-5 mm. long, spreading when moist, more or less crisped when dry, lingulate to linear-lanceolate, acute to obtuse, entire or serrulate at apex; midrib strong, ending below apex, in cross-section with 2-5, rarely to 7 guide cells, a rather well-developed stereid band below, few or no stereid cells above and the outer cells differentiated; leaves keeled, margins plane or more often recurved on one or rarely both sides for a short distance below the middle; upper leaf cells green, quadrate to transversely elongate, rarely rectangular, the walls thin to somewhat thickened, not papillose but sometimes bulging and approaching the mammillose condition especially on the upper surface of the blade and on the back of the midrib; basal cells elongate and nearly colorless, alar undifferentiated. Autoicous, male branches below the female; inner perigonial bracts ovate, ecostate, slightly denticulate at apex, outer bracts smaller, lanceolate, costate; perichaetial bracts similar to vegetative leaves; seta erect, 1.5-6 mm. long; calyptra cucullate, extending a little below the operculum; capsule oval to short-cylindric, erect and symmetric, when mature often with darker cells in 8 longitudinal lines, 8-furrowed when dry, urn 0.5-1 mm. long, with a short neck containing a few stomata; annulus none; operculum obliquely rostrate, about as long as capsule; peristome present but sometimes fugaceous, single, of 16 undivided, filiform or lanceolate teeth, smooth to obliquely striate, without median line, from a low basal membrane of 2 or 3 rows of cells; spores more or less tetrahedral, finely papillose, 13-22 μ.

TYPE SPECIES: *Weissia fugax* Hedw.

On non-calcareous rocks and in crevices, North America, South America, Europe, Asia, and Africa.

The leaves have been variously described as smooth, papillose, and mammillose. In cross-section it is evident that some cells bulge so that the leaf does not have an even surface, but the cells are not truly mammillose. The cell walls of *R. fugax* are more or less thickened, and although they have a smooth surface and are entirely without projections which could be called papillae, the walls do not appear uniform in structure, and tiny markings can be seen which may give the appearance of papillae. The form of the peristome teeth gives the most reliable distinction between *R. fugax* and *R. denticulata*, but unfortunately the teeth are often broken. The difference in width of the leaves of the two species at 220 μ from the apex can usually be depended upon to separate sterile specimens.

KEY TO THE SPECIES OF RHABDOWEISIA

1. Upper leaf cells 8-14 μ, but rarely over 12 μ; at middle of leaf 7-12 rows of cells on either side of midrib; leaves entire or serrulate 2
   2. Leaves usually 1.5-3 mm. long, if longer the apex more or less abruptly pointed; peristome teeth 90-200 μ long 3
      3. Peristome teeth filiform or subulate; leaves gradually tapering to a narrow, acute apex with 3-4 (rarely to 6) rows of cells on either side of midrib at 220 μ from leaf tip ..... 1. *R. fugax*
      3. Peristome teeth linear-lanceolate; leaves usually more abruptly pointed with 5-6 (rarely 4-8) rows of cells on either side of midrib at 220 μ from leaf tip ..... 2. *R. denticulata*
   2. Leaves 3-5 mm. long, linear-lanceolate, gradually tapering to an acute apex; peristome teeth 250-280 μ long, linear-lanceolate, obliquely striate, never subulate ..... 3. *R. africana*
1. Upper leaf cells 12-20 μ, commonly over 13 μ; at middle of leaf 10-17 (usually 12-15) rows of cells on either side of midrib; leaves plainly toothed in upper 1/4-1/3 ..... 4. *R. crenulata*

1. *Rhabdoweisia fugax* (Hedw.) BSG, Bryol. Eur. fasc. 33-36. 1846.

Weissia fugax Hedw., Sp. Musc. 64-65, t. 13. 1801.
Grimmia striata Web. & Mohr, Bot. Tasch. 143. 1807.
Weissia striata β *minor* Hook. & Tayl., Musc. Brit. 45. 1818.
Weissia pumila Brid., Bryol. Univ. 1: 338-339. 1826.
Weissia leptodon Plaubel *in* Brid., Bryol. Univ. 1: 341-342. 1826.
Weissia fugax β *gymnostoma* Hartm., Skand. Fl. ed. 5. 396. 1849.
Weissia Lindigiana Hampe, Ann. Sci. Nat. 5, 3: 352. 1865.
Rhabdoweisia Lindigiana (Hampe) Mitt., Jour. Linn. Soc. 12: 54-55. 1869.

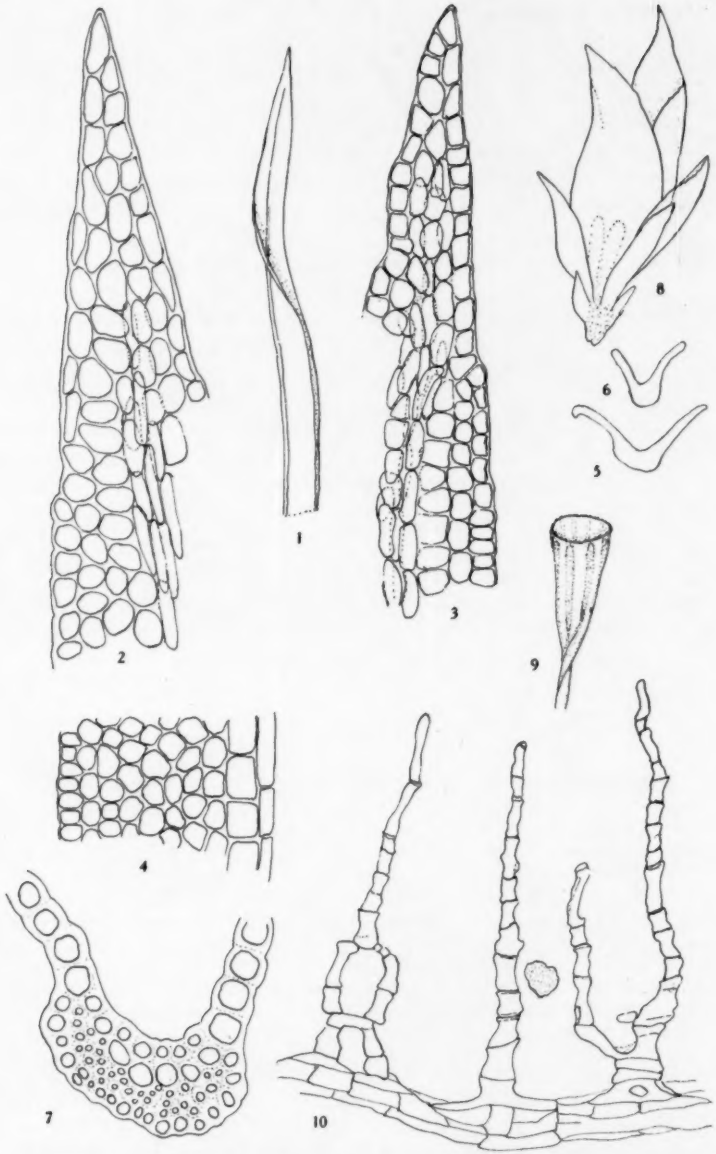

FIG. 1-10. *Rhabdoweisia fugax*, Breutel, Musci Frondosi 260. 1. Leaf, × 28. 2-3. Cells of leaf tips, × 360. 4. Cells just above leaf middle, from midrib to margin, × 360. 5-6. Cross-sections of leaf near middle and above middle, × 82. 7. Cross-section of midrib in lower part of leaf, × 360. 8. Antheridial branch, × 82. 9. Dry capsule, × 28. 10. Part of peristome, × 360.

Oncophorus striatus (Web. & Mohr) Lindb., Musci Scand. 27. 1879.

Rhabdoweisia fugax var. *subintegrifolia* Boul., Musc. France 543. 1884.

Oncophorus fugax (Hedw.) Broth., Enum. Musc. Cauc. 71. 1892.

Rhabdoweisia striata (Web. & Mohr) Kindb., Eur. & N. Am. Bryin. 2: 211. 1897.

Rhabdoweisia fugax f. *estriata* Amann, Flore Mousses Suisse 3: 10. 1933.

Rhabdoweisia fugax var. *tenerrima* Bartr. Bryol. 50: 203. 1947.

Stems 0.2-1 cm. high; leaves narrowly linear-lanceolate, 1.5-3 mm. long, margins plane or more or less recurved below, gradually tapering to a narrow apex, entire to minutely crenulate near apex; upper leaf cells 7-12 μ, quadrate or often transversely elongate, the walls usually thickened; 7-12 rows of cells on each side of midrib near leaf middle, at 220 μ from apex 3-4, rarely 5-6 rows on some leaves; midrib in cross-section with 4-5, rarely to 7 guide cells, a well-developed stereid band below and often with a few stereid cells above; seta 1-3 mm. long, urn 0.4.7 mm. long, peristome teeth smooth, to 130 μ long, rarely to 165 μ; spores 11-17 μ.

TYPE: Sudeten, the mountainous region between Czechslovakia and Silesia, Germany, collected by Ludwig, not available. NEOTYPE: From the same region as the type, Breutel, Musci frondosi 260 (NY!).

Widely distributed in Europe, in Madeira, Azores, South America, Guatemala, and reported from South Africa.

ILLUSTRATIONS: Hedw. (1801) pl. 13, f. 5-10; BSG (1846) pl. 41; Braithw. 1 (1883) pl. 26 C; Limpr. (1886) f. 102; Dixon (1924) pl. 9I.

REPRESENTATIVE SPECIMENS EXAMINED: BRITAIN: Wilson, Musc. Brit. 44 (NY). AZORES: Flores, *H. Persson,* May 1, 1937 (S-PA). GERMANY: Breutel, Musci Frondosi 260 (NY); Limpricht, Bryoth. Sil. 152 (NY); Saxony, Bauer, Musci Eur. 959, as var. *subdenticulata* Boul. (WTU). BOHEMIA: Bauer, Krypt. Exs. 887 (NY). AUSTRIA: Salzburg, Gastein, *P. G. Lorentz,* Sept. 21, 1858 (S-PA). TIROL: Warnstorf, Deutsche Laub., Aug. 1877 (NY). FRANCE: Husnot, Musci Galliae 108 (WTU). SWITZERLAND: Ticino, Locarno, *W. Traubmann* (S-PA); Bern, Grimsel, *J. Amann,* Aug. 31, 1920 as f. *estriata* Amann (ZT). ITALY: Erbar. Crittogam. Ital. 615 (NY). NORWAY: Buskcryd, N. *Bryhn,* May 1881 (S-PA); Helsingland, Kasberget, as var. *gymnostoma, Hartman,* in 1849 (NY). GUATEMALA: Dept. Quetzaltenango, Cerro de Sija, *A. J. Sharp* 5035, isotype of var. *tenerrima* (BARTRAM); San Marcos, *A. J. Sharp* 5413a, as var. *tenerrima* (TENN). VENEZUELA: Bogotá, *A. Lindig,* June 1863, as *R. Lindigiana* (Hampe) Mitt., the type (NY). BOLIVIA: Pelichuco, *R. S. Williams* 2863 (NY). JUAN FERNÁNDEZ: *Wm. Mosely,* Nov. 1875, Challenger Exp. (NY).

R. fugax and *R. denticulata* are frequently confused, especially plants that do not have peristome teeth in good condition. In *R. denticulata* the teeth are lanceolate, that is, they taper evenly from

the broad base, while in *R. fugax* they narrow abruptly from the broad base and for most of the length are of nearly uniform width. The great difficulty is in distinguishing sterile specimens and fruiting plants where the capsules are old and the teeth are broken. No leaf character is completely dependable, but three differences have been found that are helpful. In *R. fugax* the leaf margin is entire or only distantly and minutely crenulate, the leaf apex is narrower with fewer rows of cells at a short distance from the tip, as noted in the key, and the cross-section of the midrib in the lower part of the leaf shows more stereid cells and a larger number of guide cells.

There is quite a difference in the shape of the dried capsules even in the same collection. They are usually ovate and only slightly or not at all narrowed below the mouth as illustrated for *R. denticulata* in figure 20, but sometimes they are conspicuously narrowed from below the mouth and taper evenly to the seta as illustrated in figure 9. This condition was most evident in South American specimens of *R. fugax* but can also be found in European specimens.

Hartman (1849) described the var. *gymnostoma* as having smaller capsules without peristome. The specimen at the New York Botanical Garden of Hartman's variety from the locality he gives for the type is not gymnostomous. The basal parts of the broken teeth are present, attached to the mouth of the capsule.

Amann (1933) described the form *estriata* as having an entirely smooth capsule even when dry. A study of the type specimen shows some capsules that are not quite smooth, and all the capsules show cell differentiation in longitudinal lines corresponding to the position of ribs. European specimens often show a few capsules that are nearly smooth when dry, but the majority are strongly ribbed.

Bartram (1947) described the var. *tenerrima* as smaller than European specimens. An examination of many specimens from Europe and South America shows that small plants occur on both continents and that many collections are intermediate in size with no clear line of division.

According to present knowledge *R. fugax* does not occur in Japan. Through the kindness of Prof. Noguchi I was able to study a large number of specimens from Japan and they are all *R. denticulata*, although many of them had been determined as *R. fugax* or as *R. fugax* var. *subdenticulata*. *R. fugax* was reported from Natal, South Africa, by Sims in 1926 (not seen). His description and illustration show the peristome as similar to that of European specimens, but the leaves are broader at the apex.

2. *Rhabdoweisia denticulata* (Brid.) BSG, Bryol. Eur. fasc. 33-36. 1846.

Weissia denticulata Brid., Musc. Rec. Suppl. 1: 108-109. 1806.
Grimmia striata Schkuhr, Krypt. Gew. II(1): 59. 1810.
Weisia fugax β Röhl., Deutschl. Fl. ed. 2, 3: 49. 1813.
Weissia striata β *major* Hook. & Tayl., Musc. Brit. 45. 1818.
Weisia striata Drumm., Musci Amer. 68. 1828.
Oncophorus crispatus Lindb., Musci Scand. 27. 1879.
Weisia fugax var. *subdenticulata* Boul., Musc. France 543-544. 1884.
Rhabdoweisia denticulata var. *acutifolia* Limpr., Die Laubm. 1: 277. 1886.
Rhabdoweisia crispata (Lindb.) Kindb., Eur. & N. Am. Bryin. 2: 211. 1897.
Rhabdoweisia denticulata f. *compacta* Röll, Hedwigia 51: 73. 1911.
Rhabdoweisia denticulata f. *atrata* Röll, Hedwigia 51: 73. 1911.
Rhabdoweisia kusenevae Broth. *in* Fedtschenko, Flora Asiae Rossicae. 58-60. 1914.
Rhabdoweisia striata f. *subdenticulata* (Boul.) Mönk., Die Laubm. Eur. 184-185. 1927.
Rhabdoweisia denticulata var. *americana* Culmann *in* Grout, Moss Flora of N. Am. 1: 64. 1937.
Rhabdoweisia gymnostomioides Dix. & Thér. *in* Dix., Rev. Bryol. et Lichén. 13: 10. 1942.
Rhabdoweisia fugax f. *subdenticulata* (Boul.) Demar., Bull. Jard. Bot. Etat Brux. 17: 328. 1945.
Rhabdoweisia denticulata f. *acutifolia* (Limpr.) Podp., Conspectus Musc. Eur. 111. 1954.
Rhabdoweisia sinensis Chen, Feddes Rep. 58: 23-24. 1955.

Stems 0.5-1 cm. high, rarely higher; leaves ligulate to linear-lanceolate, 2-3.5 mm. long, margins plane or more or less recurved below, apex acute, serrulate or nearly entire near apex; upper leaf cells 9-15 μ but commonly 11-12 μ, the walls thin to somewhat thickened; 9-13 but more often 10-12 rows of cells on either side of midrib near leaf middle, at 220 μ from apex with 5-6, rarely 4-8 rows of cells on either side; midrib in cross-section with 2-4, rarely 5 guide cells, a well-developed stereid band below and often a few stereid cells above; seta 2-5 mm. long, urn 0.5-0.8 mm. long, peristome teeth linear-lanceolate, to about 190 μ long, but often broken, rarely longer, obliquely striate to smooth; spores 15-20 μ.

TYPE: Collected first in Scotland (Dickson, 1793); Germany by Ludwig (Bridel, 1806); type not seen. NEOTYPE: Wilson Musc. Brit. 45 (NY!).

Widely distributed in Europe; in North America from Quebec and New-

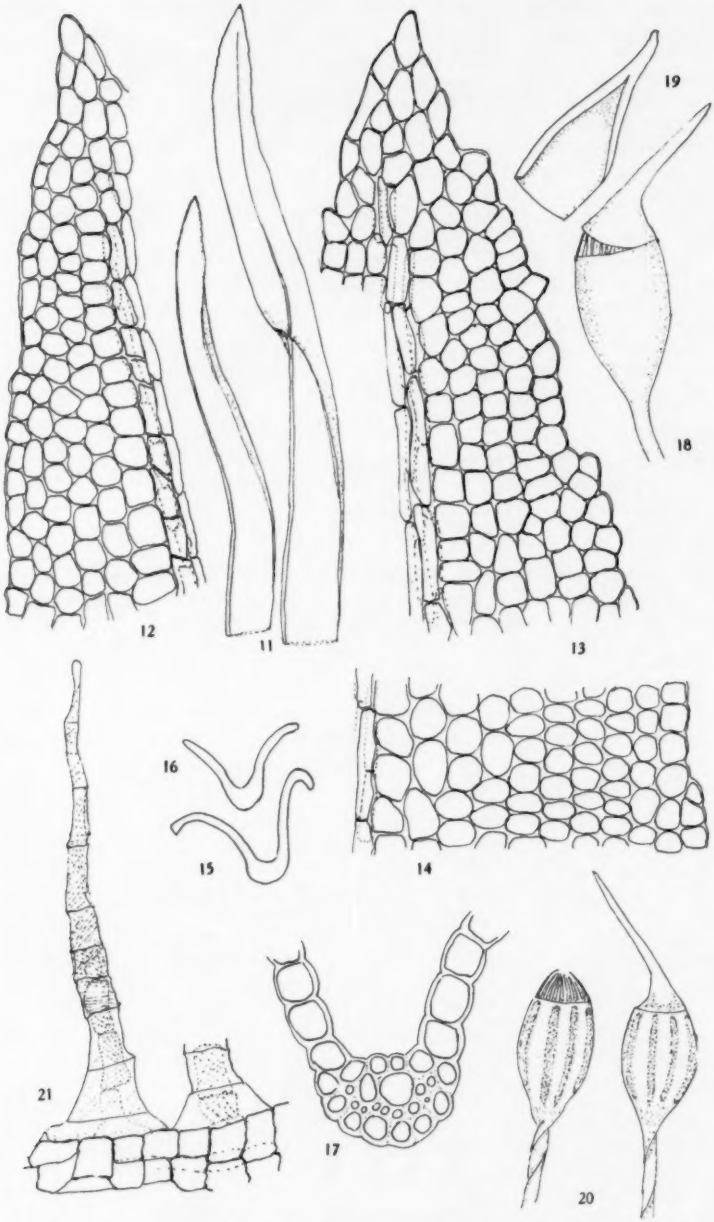

FIG. 11-21. *Rhabdoweisia denticulata*. 11. Wilson, Musc. Brit. 45, two

foundland to North Carolina, west to Tennessee, Kentucky, Ohio, West Virginia, Michigan, Wisconsin, Minnesota, Ontario, Manitoba, Alaska, Hawaii; South America in Bolivia; Asia in Amur, Japan, China, Korea, and Java.

ILLUSTRATIONS: BSG (1846) pl. 42; Braith. I (1883) pl. 26B; Limpricht I (1886) f. 103. Dixon (1924) pl. 9J;

REPRESENTATIVE SPECIMENS EXAMINED: BRITAIN; Wilson, Musc. Brit. 45 (NY). SCOTLAND: Stirlingshire, *A. C. Crundwell*, Oct. 6, 1951 (WTU). IRELAND: County Kerry, *A. C. Crundwell*, Sept. 17, 1951 (WTU). GERMANY: Prussia, Wuppertal, *J. Müller*, Wirtgen, Florae Rhennae 924 (S-PA). AUSTRIA: Steiermark, Göngraben, *J. Glowacki*, Nov. 2, 1893 (S-PA). TIROL: Ampervillgraten, *Gander*, Sept. 10, 1889 (S-PA). FRANCE: Vosges, Forêt de la Serre, *Bizot & Hillier*, 1933, as *R. fugax* var. *subdenticulata* (S-PA). NORWAY: Ryfylke, Frafjord, *L. Nyman*, Aug. 17, 1890 (S-PA). SWEDEN: Vestergotland, Kinnekulle, *Lindgren*, 1840 (S-PA). QUEBEC: Richmond Co., *Chamberlain & Knowlton* 6453 (NY). NEWFOUNDLAND: Little Ridge, *Waghorne*, Apr. 28, 1892 (NY). MAINE: Oxford Co., *J. C. Parlin*, Sept. 29, 1931 (NY). N.H.: White Mts., *J. A. Allen*, Aug. 17, 1878 (NY). VT.: Newfane, Grout, N. Amer. Musci Perfecti 10 (NY, WTU). CONN.: Sargent's Brook near New Haven, *J. A. Allen*, Sept. 13, 1879 (NY). N.Y.: Rockland Co., Austin, Musci Appalachiani 72 (NY). PA.: Bradford, Holz., Musci Acro. Bor.-Amer. 78 (NY, WTU); Bushkill, *E. B. Bartram* 689, issued as Holz., Musci Acro. Bor.-Amer. 446 (some envelopes of this number do not contain *Rhabdoweisia*), the type of var. *americana* Culmann (BARTRAM). MD.: Garrett Co., Swallow Falls, *H. S. Conard*, Sept. 13, 1950 (WTU). VA.: Lee Co., Cumberland Mts., *P. M. Patterson* S.W. 15, as var. *americana* (WTU). N. CAR.: Green Knob, *A. J. Grout*, July 30, 1907 (NY). KY.: near Cumberland Falls, *A. J. Sharp* 36230 (TENN). TENN.: Sevier Co., *A. J. Sharp* 5137 (WTU). W. VA.: McKinney's Cave near Bretz, *J. L. Sheldon*, Sept. 5, 1910 (WTU). OHIO: Hocking Co., Neotoma, *R. T. Wareham* 3392 (NY). MICH.: Alger Co., Scotts Falls, *F. E. Wynne* 1075 (NY). WIS.: Iowa Co., Canyon Pk., *Lawton* 2285 (WTU). MINN.: Cook Co., Porcupine Is., *A. J. Sharp*, Sept. 8, 1951 (TENN). ONT.: Bear Island, *R. Cain* 753 (WTU). MANITOBA: Norway House, Drummond, Musci Am. 68 (NY). ALASKA: Kodiak, *W. Trelease*, July 3, 1899, Harriman Exp. 2218 (NY). HAWAII: Saddle Road, 21 mi. from Hilo, *O. Degener* 19930 (BARTRAM). BOLIVIA: Estradillas, *T. Herzog* 3341 (S-PA). USSR: Siberia, Amur, *R. Kusenevar*, July 24, 1915, as *R. kusenevae* (H). JAPAN: Kyushu, Oita pref., Mt. Kuji, *A. Noguchi* 20653 (NOGUCHI); Honshu, Wakayama pref., Mt. Koya, *A. Noguchi* 43778 (NOGUCHI). CHINA: Prov. Szechuan, Mt. Omei, *P. C. Chen*, Series II, 62, as *R. sinensis* (S-PA). KOREA: 1st. Quelpaert, Mt. Hanra, *W. S. Hong* 60577 (NOGUCHI). JAVA: East Java, Flora Bogoriensis, May 13, 1927 (H).

This species has been confused both with *R. crenulata* and *R. fugax*. The leaf of *R. crenulata* has a broader, more rounded apex

leaves, × 28. 12. *J. L. Shelton*, Sept. 5, 1910, W. Va., cells of leaf tip, × 360. 13-21. *A. C. Crundwell*, Sept. 17, 1951, Ireland. 13. Cells of leaf tip, × 360. 14. Cells of leaf just above middle, from midrib to margin, × 360. 15-16. Cross-sections of leaf near middle and above middle, × 82. 17. Cross-section of midrib near leaf base, × 360. 18. Moist capsule, × 28. 19. Calyptra, × 28. 20. Dry capsules, × 28. 21 Part of peristome, × 360.

with the margins always plainly denticulate; there are 12-15 rows of cells on each side of the midrib, and the leaf cells are distinctly larger, the most valuable distinguishing character.

To some extent the confusion between *R. crenulata* and *R. denticulata* was brought about because of Husnot's *Musci Galliae* number 401, which was issued as *R. denticulata* and was cited by him in 1884-90. In 1890 Jameson pointed out that this moss is *R. crenulata*, and in 1892-94 under "Additions et Rectifications" Husnot made the correction. Boulay (1884) cited this same specimen as *R. denticulata*, but his description fits *R. crenulata*. In order to accommodate the other members of the genus, Boulay made two varieties of *R. fugax* which he described as follows:

a. *subintegrifolia*—feuilles entières ou faiblement sinuolées; cellules vertes opaques; peristome souvent rudimentaire.
b. *subdenticulata*—feuilles visiblement dentées, tissu moines opaque.

Thus it is quite plain that Boulay recognized our three species and that *R. denticulata* of Boulay is *R. crenulata* (Mitt.) Jameson, *R. fugax* var. *subintegrifolia* is *R. fugax* (Hedw.) BSG, and *R. fugax* var. *subdenticulata* is *R. denticulata* (Brid.) BSG.

The cell size of 10-14 μ which Limpricht (1886) gave for his var. *acutifolia* and his illustrations in figure 103 show that this is the species *R. denticulata*.

The types of *R. sinensis* Chen (1955) and of *R. kusenevae* Broth. (1914) cannot be distinguished from *R. denticulata*. *R. gymnostomioides* Dix. & Thér. (Dixon, 1942) was not available; Noguchi (1954) identified it as *R. fugax* var. *subdenticulata*.[3] The var. *americana* which Grout (1937) credited to Culmann is unnecessary for it was established because Grout confused *R. denticulata* and *R. crenulata*. This is clear because Grout cited Husnot's 401 as *R. denticulata*. The two forms of Röll (1911) are not sufficiently different from the species. Many Japanese collections identified as *R. fugax* var. *subdenticulata* were examined, and they are all *R. denticulata*. Grout (1937) and Williams (1913) included Missouri in the distribution of this species, but Bush (1916) pointed out that the Missouri record was based on what he believed to be an incorrect identification by Pech.

3. *Rhabdoweisia africana* Dixon & Nav. *in* Nav. Bull. Soc. Roy. Bot. Belg. 50: 20-21. 1927.

Stems 1 cm. or more high; leaves narrowly linear-lanceolate, 3-5 mm. long, margins plane or recurved below, gradually tapering to a narrow apex, usually serrulate in upper third of leaf; upper

[3] Two types lent by the British Museum arrived late: *R. gymnostomioides* Dix. & Thér. (Japan, Mt. Sirane, Prov. Simozuke, *H. Sasaoka*, July 13, 1927; *R. perdenticulata* Broth. & Dix. *ined.* (Darjeeling, N. India, *Mrs. F. Roper* 29, in 1911). Both are *R. denticulata*.

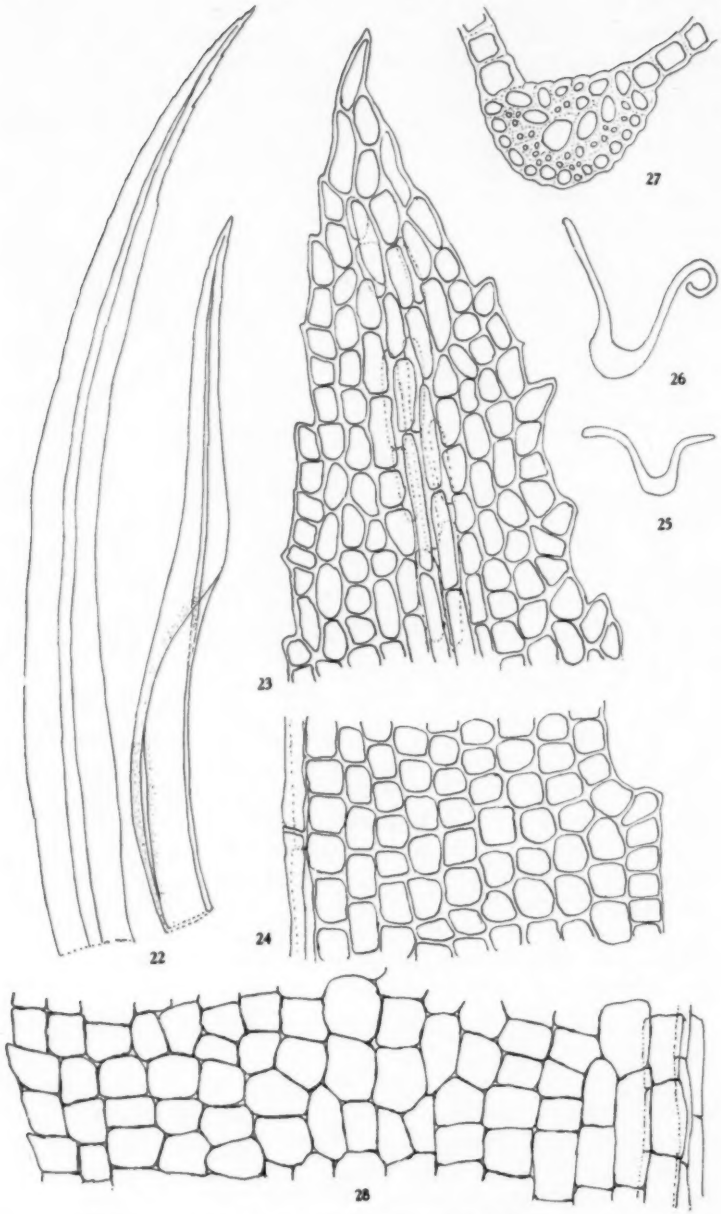

FIG. 22-27. *Rhabdoweisia africana, Bequaert* 4590, type. 22. Two leaves,

leaf cells 10-12 μ wide, quadrate or somewhat longer than wide, rarely transversely elongate, the walls somewhat thickened; basal cells elongate, 70-85 μ long; 8-12 rows of cells on each side of midrib near leaf middle at 220 μ from leaf tip usually 4 or 5 rows, rarely only 3 rows; midrib in cross-section with 4-5 guide cells, a well-developed stereid band below and often a few stereid cells above; seta 3-5 mm. long, urn to 1 mm. long; peristome well developed, teeth linear-lanceolate, 250-280 μ long, or broken and shorter, with conspicuous oblique striations; spores 17-20 μ.

TYPE: Africa: Belgian Congo, Ruwenzori, Lanuri, at about 3500 m., *J. C. Bequaert* 4590, May 29, 1914 (BR!). Known only from the type collection. A part of the Bequaert specimen were also lent by the Paris herbarium (PC).

This species was described by Dixon as near *R. denticulata*, and like *R. denticulata* it is intermediate between *R. fugax* and *R. crenulata* but in quite different characters. In fact, it is near *R. denticulata* only in the serration of the leaves. *R. africana* has a well-developed peristome, and the sporophyte scarcely differs from that of *R. crenulata*. The leaves are conspicuously longer than those of either *R. fugax* or *R. denticulata* but resemble the leaves of *R. fugax* in shape and in cell structure. The cell walls are thickened as in *R. fugax*, and the well-developed midrib with many stereid cells resembles that of *R. fugax*.

A moss collected by O. Hedberg on May 19, 1948 in Kenya in the crater of Mt. Elgon, Maji ya Moto at 3580 meters, was reported by Potier de la Varde (1955) as *R. africana*. The specimen was lent by the Institute of Botany at Uppsala. Although the sporophytes are old and the peristomes badly broken, it is evident that the teeth narrow abruptly from just above the base, and oblique striations were not seen. Thus the peristome resembles that of *R. fugax* rather than that of *R. africana*. The leaves reach 3 mm. in length, are entire or finely serrulate above, with upper leaf cells 8-9 μ; there are 8-11 rows of cells on either side of the midrib near leaf middle and 3-5 rows at 220 μ from leaf apex; the seta is 3-4 mm. long, the urn reaches 0.7 mm. and the spores are 11-15 μ. These characters indicate *R. fugax* rather than *R. africana* which is a larger plant with a well-developed peristome. Further collections from Africa with the peristomes in better condition are very desirable.

× 28. 23. Cells of leaf tip, × 360. 24. Cells of leaf just above middle, from midrib to margin, × 360. 25-26. Cross-sections of leaf, above the middle and above leaf base, × 82. 27. Cross-section of midrib in lower part of leaf, × 360.

FIG. 28. *Rhabdoweisia crenulata*, *J. D. Hooker* 270, type. Cells of leaf just above middle, from midrib to margin, × 360.

4. *Rhabdoweisia crenulata* (Mitt.) Jameson, Rev. Bryol. 17: 6. 1890.

Weissia longifolia DC. *in* Brid., Bryol. Univ. 1: 804. 1826 (*nomen nudum*).

Weissia denticulata β *longifolia* Brid., Bryol. Univ. 1: 804. 1826.

Rhabdoweisia denticulata Wils. & Mitt., Hooker's Jour. Bot. & Kew Misc. 9: 293. 1857.

Didymodon crenulatus Mitt., Jour. Linn. Soc. 1 (Suppl.): 23-24. 1859.

Rhabdoweisia sikkimensis C.M., Linn. 43: 435. 1880-82.

Oncophorus crenulatus (Mitt.) Braithw., Br. Moss Flora 1: 300. 1887.

Rhabdoweisia denticulata var. *longifolia* (Brid.) Limpr., Die Laubm. 1: 277. 1886.

Leptodontium Rossii Stirt., Trans. & Proc. Bot. Soc. Edinb. 26: 424. 1915.

Rhabdoweisia laevidens Broth. *in* Handel-Mazzetti, Symbolae Sinicae 4: 21. 1929.

Rhabdoweisia denticulata f. *longifolia* (Brid.) Podp., Conspectus Musc. Eur. 111. 1954.

Stems 1-3 cm. high; leaves lingulate, 2-4 mm. long, margins plane or somewhat recurved on one or both sides below, apex rounded-obtuse to broadly acute, denticulate by projecting cells in the upper 1/4 to 1/3; midrib with 2 or 3 guide cells and a small stereid band below; upper leaf cells with thin walls, 12-20 μ but commonly 14-18 μ; 10-17 but more often 12-15 rows of cells on each side of midrib near leaf middle, at 220 μ from apex with 7-9, rarely 11 rows of cells on each side of midrib; seta 3-6 mm. long, urn 0.6-1 mm. long, peristome teeth linear-lanceolate, to 300 μ long, but often broken and shorter, typically obliquely striate; spores to 22 μ.

TYPE: Sikkim, *J. D. Hooker* 270 in Mitten herbarium (NY!).

Found in British Isles, Germany, Belgium, France, Sikkim, China, and Formosa.

ILLUSTRATIONS: Braithw. (1887) pl. 45E; Dixon (1924) pl. 9K.

REPRESENTATIVE SPECIMENS EXAMINED:—ENGLAND: Westmoreland, *Jameson*, Aug. 27, 1889 (NY). GERMANY: Baden, *Jack, Leiner, & Stitzenberger*, Krypt. Badens 372, as *R. denticulata* (NY); Verdoorn, Musci Selecti et Critici, Ser. III, 150 (WTU); Bauer, Musci Eur. 74b (S-PA). BELGIUM: Namur, Gravet, Bry. Belg. 52, as *R. denticulata* (NY). FRANCE: Hte-Garonne, Husnot, Musci Galliae 401 (NY). SIKKIM: *Hooker* 270 (holotype NY). CHINA: Yünnan, *Handel-Mazzettii* 1866, as *R. laevidens* Broth. (W). FORMOSA: Prov. Tainan, Mt. Kodema, *A. Noguchi* 7193 (NOGUCHI).

This species is quite distinct in its larger size, larger leaf cells, broad leaf apex and well-developed peristome. Except in Britain

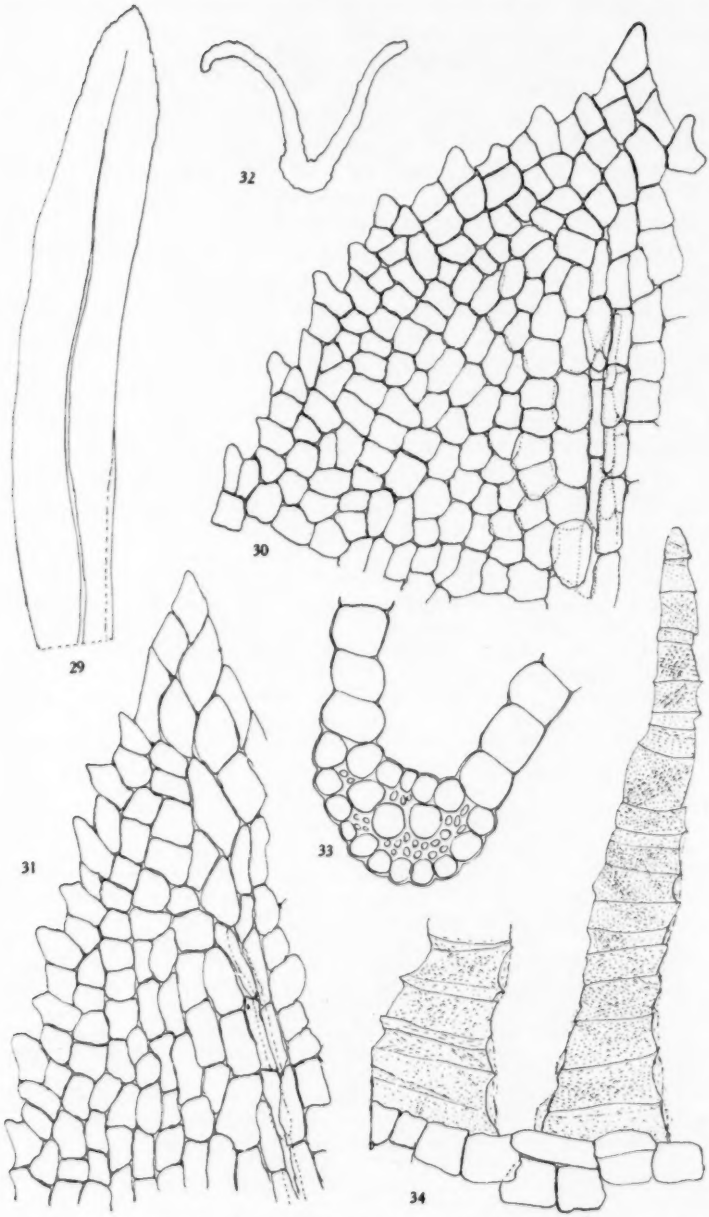

FIG. 29-34. *Rhabdoweisia crenulata, J. D. Hooker* 270, type. 29. Leaf,

there has been confusion between *R. crenulata* and *R. denticulata*. Limpricht (1886) in his description of *R. denticulata* gave the cell size as 14-17 μ and cited *Jack, Leiner & Stitzenberger's 372*, but this moss is plainly *R. crenulata*. However, Limpricht gave the var. *longifolia* under *R. denticulata* and described it as a more robust form, and therefore this variety becomes a synonym of *R. crenulata*. Wilson and Mitten (1857) listed the moss collected in Sikkim by J. D. Hooker as *R. denticulata*, the specimen which was later described as *R. crenulata* by Mitten in 1859, the type of the species. In 1929 Brotherus described a moss collected by Handel-Mazzetti in China as a new species, *R. laevidens*. This specimen which was lent by the Vienna Museum differs in no way from *R. crenulata* except that the peristome teeth show no striations. However, the capsules were quite young. Brotherus described it as having smooth teeth, and this was really the important character in making it a new species, but the capsules were not fully developed. Specimens of *R. denticulata* are found with smooth teeth, with well-developed striae on the teeth and all intermediate stages. Therefore it does not seem necessary to make the specimen from China a new species.

Excluded and Doubtful Names

Weissia Ludwigii Brid., Musc. Rec. Suppl. 1: 109. 1806 (*nomen nudum*). Bridel (1826) made this a synonym of *W. denticulata*.

Weissia striata Kaulf. *in* Sturm, Deutschl. Fl. 2(16): 5. 1818. This is probably *R. denticulata* judging by the illustration of the peristome teeth.

Weisia vulcanica C. Müll., Syn. Musc. Frond. 1: 649-650. 1849. *Rhabdoweisia vulcanica* (C. Müll.) Mitt., Jour. Linn. Soc. 12: 55. 1869. The specimens at the Stockholm herbarium (type) and at the herbarium at Helsinki which were collected by Ehrenberg in Mexico, Terra de los Nebijos, have strongly papillose leaves and are not *Rhabdoweisia*. Mitten described the leaves as papillose, and the specimen is probably *Amphidium cyathicarpum*, but it is sterile.

Weisia sphaerothecia C. Müll., Linn. 43: 435. 1880-82. *Rhabdoweisia sphaerothecia* (C. Müll.) Par., Index Bryol. ed. 2. 4: 143. 1905. Müller described this species from a moss collected by Lorentz in March 1872 in Argentina near Tucumán. An examination of the type from the Stockholm herbarium shows that it is *Amphidium cyathicarpum* (Mont.) Broth.

Rhabdoweisia gymnostoma Besch., Jour. de Bot. 13: 44-45. 1899. Bescherelle described this species as a moss without a peristome from a specimen collected in Japan (*Faurie* 14030). Faurie's specimen in the Stockholm herbarium was studied, and the leaves are strongly papillose indicating that it does not belong to *Rhabdoweisia*. Noguchi (1954) placed it correctly in the genus *Hymenostomum*.

Rhabdoweisia fugax var. *collenchymatica* Fröhl., Arch. Hydrobiol. Suppl. 21 (3/4). 308. 1955. The type of this variety was lent by the Vienna Mu-

× 28. 30-31. Cells of tips of leaves from same plant, × 360. 32. Cross-section of leaf near middle, × 82. 33. Cross-section of midrib near leaf base, × 360. 34. Part of peristome, × 360.

seum. In shape the leaves resemble those of *R. denticulata* rather than those of *R. fugax*, but owing to the small amount of material it was not possible to place the moss definitely. It was collected in Java by Prof. F. Ruttner in 1928-29. *R. fugax* is unknown from Asia, whereas *R. denticulata* is found in Amur, China, Korea, and Java. It is doubtful that it is sufficiently different to be a variety. Thick-walled cells are common in *R. fugax* and are often found in *R. denticulata* when the specimens are old.

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THE GENERA THYSANANTHUS, PTYCHOCOLEUS, TUZIBEANTHUS, PHRAGMILEJEUNEA, AND BRACHIOLEJEUNEA (LEJEUNEACEAE HOLOSTIPAE)

Rudolf M. Schuster[1]

In a study of the cytological features of the Lejeuneaceae, Schuster and Hattori (1954) described the oil bodies of the majority of genera of the Holostipae, a subfamily with entire underleaves. Certain by-products of that study are now becoming evident; one of these I intend to discuss in this contribution, namely, the limits of the four allied genera, *Tuzibeanthus, Ptychocoleus, Phragmilejeunea,* and *Brachiolejeunea.* These four genera have certain features in common which have led to a confusion of their limits. This first became evident shortly after the paper by Dr. Hattori and myself appeared, in conjunction with the species *Brachiolejeunea nigra* St. Dr. E. W. Jones, after reading our paper, noted (*in litt.,* 1955) that on the basis of oil bodies we had placed *Tuzibeanthus* (and *Phragmilejeunea*) in the Ptychanthus group, defined by the presence of several rather large, coarsely segmented oil bodies. By contrast, we had placed *Brachiolejeunea* and *Ptychocoleus* in the Spruceanthus group, characterized by numerous, minute or small, homogeneous oil bodies. Yet Jones noted, "My recollection is that so far as I have seen them the African *Ptychocoleus* spp. have the *Ptychanthus* (*Mastigolejeunea*) type of oil-body. *Brachiolejeunea nigra* has this type also." This statement, of course, immediately challenged the concept that major oil body types were confined to individual genera in the Holostipae, a premise which the experience of Hattori and myself had led us to accept. The present paper is an attempt at solving this seeming *impasse.*

Since the preceding was written, Jones (1957) has noted that, after I had pointed out to him "that the oil bodies of typical

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Brachiolejeunea are small and simple, the lobules are several-toothed, and the female bracts have winged keels," he had also arrived at the conclusion that *"Brachiolejeunea" nigra* must be returned to *Mastigolejeunea,* in which Stephani had originally described it. Indeed, Jones admitted that *Brachiolejeunea camerunensis* Jones & V. Bergh. is the only African species which corresponds to *Brachiolejeunea* in these respects; the other two species are best transferred to *Mastigolejeunea.*

I cannot help noting that Dr. S. Arnell helped us, indirectly, in demonstrating the correctness of our view that the oil body types are major systematic features in the Lejeuneaceae. He had shortly before (1953) described a *Lejeunea convexa* from South Africa, with 1-2 large, coarsely segmented oil bodies per cell. On the basis of our experience with a variety of Lejeuneaceae, we stated (1954, p. 50) that "judging from the large size of the trigones, and from the few and large oil-bodies, this species cannot belong in *Lejeunea* s. str." We implied that it might belong to *Rectolejeunea, Cheilolejeunea,* or *Euosmolejeunea,* since "similar oil-bodies . . . occur" in these genera. Shortly after Dr. Arnell received a copy of our paper, he wrote that our assumptions (which it is to be noted were based on his description of the cellular characters of the plant *without any available material for study*) were correct, *Lejeunea convexa* actually being a species of *Cheilolejeunea!* The following year he (1955) formally placed it in the latter genus.

THE LIMITS OF BRACHIOLEJEUNEA, MASTIGOLEJEUNEA, AND TUZIBEANTHUS. As stated above, Jones called attention to the fact that the African *Brachiolejeunea nigra* St. has oil bodies as in *Mastigolejeunea, i.e.,* large, coarsely segmented, and only several per cell. The plants studied were kindly lent by Dr. Jones. Schuster and Hattori had already established that in the American and Asiatic *Brachiolejeuneae* the cells each possessed numerous small, homogeneous, glistening oil bodies. In connection with a revision of the North American Lejeuneaceae, I had further established that typical *Brachiolejeuneae,* including *B. laxifolia,* the generitype, possess a set of characteristics that sharply define the genus, among them: (*a*) the female bracts possess a distinct wing or lamella on the keel, a characteristic nearly unique in the Lejeuneaceae; (*b*) the underleaves do not, or rarely, possess sharply reflexed margins; (*c*) the lobules normally possess, in all examined species, including the generitype, several small marginal teeth along the free margin; (*d*) the stem possesses a very distinct, obvious hyalodermis of rather thin-walled, enlarged cells of greater diameter than those of the medulla. These four criteria were correlated, of course, with the occurrence of homogeneous oil bodies.

It needs to be pointed out that *B. laxifolia,* although typical of the genus in the above respects, is not known to us from living material; hence the occurrence of homogeneous oil bodies in this species needs to be established.

However, *B. laxifolia* has a trigonous perianth and strongly obcordate underleaves—two criteria that are wholly atypical—*Brachiolejeunea* being defined in all recent works as having a pluriplicate perianth. The implications of this will be discussed in detail in a forthcoming paper on the genera of Lejeuneaceae (Schuster, 1961).

Brachiolejeunea nigra, by contrast, shows (*fide* Jones) a few large, segmented oil bodies per cell. Careful study of the species further demonstrated that none of the above features, outlined for *Brachiolejeunea,* was found but that (*a*) the female bracts lack a wing along the keel; (*b*) the underleaves have more or less reflexed margins, hence appear concave in postical aspect; (*c*) the lobule lacks marginal teeth, other than the apical one; (*d*) the stem does not show a markedly distinct hyalodermis, the cortical cells lying in many more rows, being hardly larger than the medullary. The stem anatomy is thus similar to that of *Mastigolejeunea,* with which *Brachiolejeunea nigra* also agrees in (*a*) the non-dentate lobule margins; (*b*) oil body type; (*c*) the keel of the bracts not winged; (*d*) the form of the underleaves. Indeed, the only "good" characters at once evident that would separate *Brachiolejeunea nigra* from typical species of *Mastigolejeunea* lie in (*a*) the frequent occurrence of two subfloral innovations in the former vs. the nearly uniformly single innovations in the latter; (*b*) the pluriplicate perianth vs. the trigonous perianth of *Mastigolejeunea.* It must be admitted that the former is not, *per se,* a convincing generic character, especially since *Brachiolejeunea* varies considerably in this respect. The perianth form also must be admitted to be of questionable generic importance. As we have seen above, "normal" *Brachiolejeuneae* are provided with a pluriplicate perianth, while the generitype forms an exception in being provided with only three rounded perianth keels (of which the ventral is more or less longitudinally sulcate). Similarly, the juvenile perianths of *Brachiolejeunea nigra* appear to be provided, consistently, with only three rounded keels—the pluriplicate condition developing secondarily, with maturation.

Indeed, I would question the advisability of attempting to separate genera in the *Brachiolejeunea-Ptychocoleus* complex (with a hyalodermis and with homogeneous, minute oil bodies) and in the *Mastigolejeunea-Thysananthus* complex on the basis of differences in number of plicae of the perianth. In these complexes, as well as in all "typical," infuscated HOLOSTIPAE, the perianth is primitively trigonous; the development of additional plicae can be interpreted as secondary. This can arise either by the development of accessory plicae in the areas *between* the primary plicae, as is obviously the case in *Brachiolejeunea nigra* and such allied species as *Mastigo-*

lejeunea florea, or else the additional plicae appear to arise by the primary plicae becoming sulcate, as is apparently true in "typical" species of *Brachiolejeunea* and *Ptychocoleus*. However these secondary conditions arise, we must admit that the gamut of variation from primitively trigonous to pluriplicate can occur ***within*** a single genus and that any attempt to use the number of plicae as a primary generic character is foredoomed to failure in these groups.

Equally devoid of generic significance, in my estimate, is the opposed tendency of suppression of plicae. In *Phragmilejeunea* the perianths "tend" to become inflated, with the three basic plicae obliterated, secondarily, to a greater or lesser extent. Here again, surely, the secondary perianth modification, *per se*, can have only an accessory generic value.

As a consequence of the above observations, I for some time was of the opinion that *Brachiolejeunea nigra* was an "atypical" species of *Mastigolejeunea* and expressed an opinion to this effect to Dr. Jones, in correspondence. However, in its perianth characters *Brachiolejeunea nigra* appears possibly to be even more similar to *Tuzibeanthus*, a monotypic Japanese endemic described by Hattori (1948). *Tuzibeanthus* is dioecious and unfortunately known only with juvenile perianths. It agrees with both *Brachiolejeunea nigra* and *Mastigolejeunea* in the following respects: (*a*) stem anatomy; (*b*) few, segmented, large oil bodies; (*c*) imbricate underleaves with more or less reflexed margins; (*d*) gynoecia innovating below; (*e*) lobules of leaves with a single distinct apical tooth, the pre-apical tooth, if present, obscure; (*f*) cells with trigones not of the *Brachiolejeunea*-type, *i.e.*, not consistently with two convex sides and one concave side; (*g*) bracts with keels not winged. *Tuzibeanthus* differs primarily from *Mastigolejeunea* in the 5-9-plicate perianth. In this respect, *Brachiolejeunea nigra* agrees more closely with *Tuzibeanthus*, although the juvenile perianths are provided with only three keels. Admittedly, both *Tuzibeanthus* and *Mastigolejeunea* bear single gynoecial innovations; in *Brachiolejeunea nigra* and the closely related *B. rhodesiae* there are two. On these bases, the writer concludes that *Brachiolejeunea nigra* is definitely not a *Brachiolejeunea*, whatever criteria we may use, but should be placed in either *Mastigolejeunea* or *Tuzibeanthus*.

To place the so-called species of *Brachiolejeunea* that seem intermediate between *Mastigolejeunea* and *Tuzibeanthus* is therefore quite problematical. A study of the branching patterns suggests at least one solution. The material of *Tuzibeanthus* which I have studied shows uniform branching of the *Frullania*-type; *i.e.*, the branches are terminal and replace the ventral half of a normal leaf and are thus associated with an elobulate leaf. In *Brachiole-*

jeunea nigra and *rhodesiae*, as well as in all true species of *Mastigolejeunea* I have studied, branching appears to be uniformly of the so-called *Lejeunea*-type, the branch arising immediately posterior to a normal, lobulate leaf. It must be admitted, however, that in *Brachiolejeunea* branching of both types occurs; hence, in itself, the observed differences in branching cannot be considered as warranting a distinct genus.

An analysis of the rather involved relationships portrayed here suggests that perhaps the simplest solution to the entire problem is to consider the three elements here discussed (*Mastigolejeunea* s. str., *Tuzibeanthus*, and the *Brachiolejeunea nigra-rhodesiae* complex) as elements of a single genus, *Mastigolejeunea*. Possibly to be added as representatives of subgenera are two isolated species, *Mastigolejeunea integrifolia* (St.) Verd. and *M. paradoxa* Verd. The problem of these two species will be discussed elsewhere (Schuster, 1961). For the time being, the three groups recognized here may be separated by the key concluding this paper. It should be noted, however, that the subgenus TUZIBEANTHUS bears close affinities also to *Ptychanthus*, with which it agrees in the *Frullania*-type of branching and the pluriplicate perianth, as well as in the segmented fat bodies. It differs from *Ptychanthus* primarily in the entire leaves and bracts. It is possible that this latter distinction is of relatively less value and that the following arrangement of taxa will be found more natural:

Ptychanthus (vegetative branches of the *Frullania*-type).
  Subgenus PTYCHANTHUS.
  Subgenus TUZIBEANTHUS.
Mastigolejeunea (vegetative branches all of the *Radula*-type).
  Subgenus MASTIGOLEJEUNEA.
  Subgenus THYSANANTHUS.

Such an arrangement presumes that the presence of teeth of bracts and leaves, bracteoles and underleaves, and sometimes of perianth keels is systematically less significant than the type of branching.

In this connection it should be noted that there are excellent reasons for considering *Thysananthus* and *Mastigolejeunea* as congeneric; the features which separate them are vegetative differences, at times of slight significance! In *Thysananthus* the leaves and underleaves "tend" to be dentate, as do the floral leaves and underleaves; similarly, the perianth keels "tend" to be toothed. These structures are entire in *Mastigolejunea*. Therefore, irrespective of the position we assign the monotypic *Tuzibeanthus*, the other two genera, *Mastigolejeunea* and *Thysananthus*, should possibly be united. (Significant in this connection is the study of such

species as *"Mastigolejeunea" selingii* Herz., Ark. Bot. 3(3): 60. Fig. 9. 1951, with entire leaves and underleaves, but with a bilobed and toothed bracteole, and teeth on the lobule of the bracts.). As shown above, the *"Brachiolejeunea" nigra-rhodesiae* complex belongs in any such genus, however narrowly or broadly defined it may be. Because of the development of geminate innovations and the presence of accessory plicae, this complex may deserve segregation into a distinct subgenus.

THE GENERA PTYCHOCOLEUS AND PHRAGMILEJEUNEA. As we have seen from the foregoing, the genus *Mastigolejeunea* is characterized by several features: (*a*) segmented, large oil bodies; (*b*) trigonous perianths; (*c*) a non-differentiated stem cortex; (*d*) a lobule with one distinct apical tooth and sometimes a small, preapical one but never with a denticulate free lobular margin. These criteria need to be kept in mind in the following discussion, since they apply in conjunction with the study of the African species generally assigned to *Ptychocoleus*. As we have seen, Jones noted that, insofar as he had seen them, the African species of *Ptychocoleus* possess oil bodies of the *Mastigolejeunea*-type (few, large, coarsely segmented ones). Arnell (1953) had also ascribed *Mastigolejeunea*-like oil bodies to *Ptychocoleus pappeanus*, whereas *Ptychocoleus heterophyllus* Evans and *P. nipponicus* Hatt. were shown by Schuster and Hattori (1954) to have homogeneous, numerous, small oil bodies of the *Spruceanthus* type. These species also have perianths with five or more deep, long carinae.

Evidently, we have here again a situation in which the oil body characteristics suggest that generic limits have been incorrectly drawn. I stated (footnote, p. 27, in Schuster & Hattori, 1954) that the Japanese and neotropical species of *Ptychocoleus* have oil bodies differing "not only in number, but in size and structure" from those of *Ptychocoleus pappeanus* and, furthermore, that the latter differs also in "form of the lobule," which has a single tooth on the free margin, whereas *Ptychocoleus* has few to several marginal teeth, as in *Brachiolejeunea*. The perianth is also deviant, that of *Ptychocoleus* being pluriplicate, while in *P. pappeanus* it is barely trigonous at the very summit and terete and inflated below. On that basis I concluded then, and still maintain, that the African *Ptychocoleus pappeanus* is not a true *Ptychocoleus*. In the form of the lobule, in the trigonous perianth, and in the oil bodies it again approaches more closely *Mastigolejeunea* and the allied *Tuzibeanthus*. It differs from these two genera in the lack of subfloral innovations. The stem anatomy is also of the *Mastigolejeunea* type: there are numerous rows of thick-walled cortical cells aver-

aging no larger than the thick-walled medullary cells; as a consequence, the *P. pappeanus* stem is simple and does not show a hyalodermis.

It also deserves to be re-emphasized (Schuster & Hattori, 1954) that the generitype of *Ptychocoleus*, *P. aulacophorus* (see Evans, 1908), has lobules with 7-8 small marginal teeth and a pluriplicate perianth. In this it approaches *P. heterophyllus* Evans from the New World. Since the latter has numerous, small, homogeneous oil bodies, it is presumed that the generitype (and all true species) of *Ptychocoleus* have such oil bodies. Therefore, the segregation of *"Ptychocoleus" pappeanus* into a discrete genus, *Phragmilejeunea* Schust., appears well justified. A re-examination of the African species is needed, and the writer predicts that if they show oil bodies of the *Mastigolejeunea*-type, they will also show other deviations from *Ptychocoleus* that will necessitate their exclusion from that genus. The assignment of the African *Ptychocoleae* with 1-2-dentate lobules and tricarinate perianths thus remains an open matter, *until* these species are studied cytologically.

There are apparently a few *bona fide* members of *Ptychocoleus* in which there is a single, sharply marked apical tooth (and, at most, a poorly marked pre-apical tooth), such as *P. nipponicus* Hatt. In spite of the deviant lobuli, this species has numerous minute, homogeneous oil bodies (Schuster & Hattori, 1954, fig. 1:6). This species is also somewhat deviant in having 5-carinate perianths, with two well-marked ventral keels, and a marked dorsal keel. There are several other species in the genus, besides *P. nipponicus*, which do not show the *Ptychocoleus* character-constellation to a high degree; these all need to be investigated as to oil bodies and stem anatomy.

Judging from perianth features and form of the lobuli of the leaves, *"Ptychocoleus" molleri* and *"P." occultus* must be removed from *Ptychocoleus* and transferred to *Phragmilejeunea*. Jones (*in lit.*) informs me that the former has perianths "which are completely eplicate and others which are distinctly plicate in the upper part . . . found in the same gathering." *P. occultus* is described by Jones (1954) as having a smooth perianth "with 5 weak keels at apex only"; this strongly suggests the genus *Phragmilejeunea*, as does the description of the gynoecium at the "extrémité d'un rameau assez court, dressé, n'innovant pas" (Vanden Berghen, 1948). Indeed, of the African species attributed to *Ptychocoleus* (Jones, 1954; Vanden Berghen, 1948) only a minority, such as *P. emergens* (Mitt.) St. and *P. renauldii* St., appear to be true *Ptychocoleae*. Jones (1957) has already shown that *Ptychocoleus yangambiensis* V. Bergh. is a *Caudalejeunea!* Thus a major reorientation of species appears to be necessary in this complex, based, in part, on stem anatomy, in part on form of oil bodies.

The genus *Phragmilejeunea* itself must come under renewed investigation. When proposed, I believed it could not be identical with any of the previously described genera of Lejeuneaceae HOLOSTIPAE. Since I proposed the genus I have studied Verdoorn's *Schiffneriolejeunea*, which also has erostrate, completely included perianths with 5(-7) weak plicae and sulci near the apex of the otherwise inflated and smooth perianths. Certainly, *Phragmilejeunea* and *Schiffneriolejeunea* are very closely allied, and it may prove necessary to unite them. The former has, in investigated material, 15-18 rows of cortical cells; in *Schiffneriolejeunea* there are 20-36 rows of cortical cells. In neither group are the cortical cells differentiated as a hyaloderm. Both groups also agree in one very striking and suggestive feature: the gynoecia are terminal on rather short, lateral branches, which, although devoid of subfloral innovations, do produce tertiary branches 1-2 leaf pairs below the bracts. It should be noted that Verdoorn (1934, pp. 42-43) keyed out *Schiffneriolejeunea* as having ♀ inflorescences with innovations on one or both sides and with the gynoecia terminal on leading branches or main stems. On that basis, I had assumed, when I described *Phragmilejeunea*, that no affinity to *Schiffneriolejeunea* could exist. In actuality, the two groups agree closely in branching patterns. Furthermore, Verdoorn (*loc. cit.*, p. 149) gave as one of the "Unterscheidungsmerkmale" of *Schiffneriolejeunea* the "innovationsfreie ♀ Infloreszenzen" which are "terminal an kurzen . . . Seitenästen"—thus contradicting his own key.

On this basis, a careful, point-by-point comparison of all species involved may show the necessity of placing *Phragmilejeunea* in synonymy under *Schiffneriolejeunea*.

I am indebted to Dr. S. Arnell for an authentic specimen of *Phragmilejeunea pappeana*. Dr. E. W. Jones kindly sent material of *Phragmicoma molleri* St. [Bot. Jahrb. 8: 86. 1887. *Ptychocoleus molleri* (St.) St., Sp. Hep. 5: 29. 1912.] The latter also belongs to *Phragmilejeunea* and is presented here as a new combination, **Phragmilejeunea molleri.**

THE RELATIONSHIPS OF TROCHOLEJEUNEA TO BRACHIOLEJEUNEA. The genus *Trocholejeunea* was proposed by Schiffner (1932) for the single species *Trocholejeunea levieri* Schiffn. He emphasized as generic features the peculiarly cristate-plicate, short and included perianth, the bidentate margin of the lobules of the leaves and the dimorphism of the gynoecial bracts. The latter are lobulate on one side of the gynoecia and elobulate on the other. Verdoorn (1934) re-defined the genus to include *Brachiolejeunea pluriplicata*, with a very different perianth, narrowly terete and

with smooth, long plicae. This species, furthermore, has the bracts of both sides of the gynoecium identical, both with lobules well developed. At first glance the position of this species within *Trocholejeunea* appears quite strange, the only obvious feature in common with *T. levieri*, and the feature that led Verdoorn to include it in *Trocholejeunea*, being the bidentate lobular margin of the leaves, *Brachiolejeunea* supposedly having a pluridentate lobular margin.

On studying a long series of species assigned to *Brachiolejeunea*, it soon became evident that neither the basis used by Schiffner to found *Trocholejeunea* (the peculiar perianths and dimorphous bracts) nor that used by Verdoorn to preserve it (the bidentate lobular margin) were correlated to any degree with other characters. Two species serve to illustrate this point. *Brachiolejeunea sandvicensis* has a "typical" *Brachiolejeunea* perianth, short and virtually included, about 8-plicate, with smooth, non-cristate perianths. In other words, it fails to show the peculiarities characteristic of the perianths of *Trocholejeunea pluriplicata* and *T. infuscata*. However, this species also has dimorphous bracts. In *Brachiolejeunea sandvicensis*, furthermore, the bracts are intermediate between those of *Trocholejeunea pluriplicata* and *T. infuscata*: both bracts are lobulate, but one bears only a rudimentary lobule. Judging from the literature, this rudimentary lobule may be wholly suppressed in some instances. *Brachiolejeunea aliculata* (Herzog, 1951, p. 50) closely approaches *B. sandvicensis* in this and several other respects. It has the same type of perianth, although the keels are unusual in being slightly carinate or even winged. It also possesses dimorphous bracts, one with a well-developed lobule, the other without. Herzog, studying this species, concluded that he could not accept *Trocholejeunea*. On a generic basis, I am fully in agreement with him.

The four preceding species, however, if carefully compared with each other, show several features in common suggesting that, although not closely allied to each other, they nevertheless form a series sufficiently distinct from *Brachiolejeunea* s. str. to deserve subgeneric recognition. The most important feature they share is that the gynoecial bracts never bear a wing along the keel, a feature typical of all species of true *Brachiolejeunea* which I have studied. The species with wingless keels of the bracts also have in common a small number of teeth on the lobules. In *Trocholejeunea infuscata* and *pluriplicata* there are two teeth; in *Brachiolejeunea aliculata* there are three; in *B. sandvicensis* there are four. Typical species of *Brachiolejeunea* show a variation from four to eight teeth per lobular margin. A final character shared by these

four species is the almost constant occurrence of the gynoecia on long, leafy branches. Typical species of *Brachiolejeunea* normally have gynoecia on abbreviated lateral branches, although the generitype itself is an exception to the rule!

I therefore suggest that we maintain *Trocholejeunea* as a subgenus for those species in which (*a*) the gynoecial bracts never develop lamellae or wings along the keels; (*b*) the bracts show a marked tendency, absent only in *B. pluriplicata*, to become dimorphous; (*c*) the leaves show a small number of lobular teeth, usually 2-3 per lobule, only rarely 4. Associated with these tendencies is a tendency for the perianth to become specialized in various directions, as contrasted to the typical *Brachiolejeunea* perianth. These perianth specializations I regard as secondary in importance.

Brachiolejeunea is therefore divided into two groups as follows:

1. Subgenus BRACHIOLEJEUNEA: Perianths 3-12-plicate; bracts isomorphous, both with well-developed lobules, the keel winged or lamellate; innovations 2, partially united with bracts (by the lamellae of the bracts); gynoecia on short lateral branches.—This subgenus is still polymorphous and includes two chief types: the generitype, *B. laxifolia*, with a trigonous perianth; and the other species, with pluriplicate perianths. Eventually these two types may need to be placed in separate subgenera. (This problem will be discussed in a forthcoming paper.).

2. Subgenus TROCHOLEJEUNEA: Perianths pluriplicate, the plicae commonly modified; bracts isomorphous (*B. pluriplicata*) or dimorphous, but the lobulate bract or bracts always with the keel wingless; innovations commonly 1, occasionally 2, free from bracts; gynoecia almost constantly on long, leafy, leading axes.—The type species is **Brachiolejeunea infuscata** (Mitt.) comb. nov. (*Lejeunea infuscata* Mitt., Trans Linn. Soc. London. Bot. 5: 111. 1861. *Trocholejeunea levieri* Schiffn., Ann. Bryol. 5: 160. 1932). Additional synonymy is given in Verdoorn (1934, p. 190).

KEY TO TAXA DISCUSSED.

1. Stem without a distinct hyalodermis: the numerous [(16)24-54] rows of cortical cells not markedly enlarged, not strongly thin-walled; bracts of the gynoecia with keel never winged; usually with 1 subfloral innovation (the primary gynoecium sometimes with 2 innovations) or subfloral innovation absent; lobules with 1(-2) marginal teeth at or near the apex; cells with ca. 2-5(8-10) large, obviously and rather coarsely segmented fat bodies (MASTIGOLEJEUNEA group) 2
1. Stem with a ± distinct hyalodermis, formed of strongly enlarged, rather thin-walled cells, in 19-24 rows, contrasted to the usually thick-walled, smaller medullary cells; lobules on margins with usually (2-3)4-9 small, 1-3-celled sharp teeth; cells each with numerous (over 15, up to 40 or more) minute, glistening, homogeneous oil bodies; perianths ordinarily pluriplicate (BRACHIOLEJEUNEA group) 8

2. Gynoecia with 1 or 2 subfloral innovations; perianth strongly 3-9-plicate, the plicae not confined to apices of the perianths 3
2. Gynoecia without subfloral innovations; perianths inflated, short and included, varying from almost wholly eplicate to weakly 3-5-7-plicate near

the mouth to obtusely plicate distally; lobule at apex with 1-2 apical teeth; branches of *Lejeunea*-type; leaves, underleaves, bracts, and bracteoles entire, as in *Mastigolejeunea* 7

3. Bracts, leaves, bracteole, and underleaves uniformly entire; underleaves obdeltoid, truncate to retuse, but not bilobed at apex (*Mastigolejeunea*) .. 4
3. Leaves, bracts, bracteoles, and underleaves ± dentate; usually with 1 subfloral innovation 6

4. Vegetative branches all of the *Frullania*-type; perianth obtusely 5-7-plicate when young; lobule short, with the sinus at an angle to the lobe, with usually two teeth distinct; innovations always 1, the secondary as well as primary stems prostrate, laxly leafy, the leaves not imbricate and convolute when dry; gynoecia on short, secondary branches ..... Subgenus TUZIBEANTHUS
4. Vegetative branches all of the *Lejeunea*-type; perianth fundamentally trigonous, at least when young, the primary carinae sharp and high; lobule usually strongly elongated, gradually narrowed distally, with 1 (rarely a trace of a second) apical tooth; secondary stems ascending; leaves convolute when dry and closely imbricate; primary gynoecia on long, leafy branches (subgenus MASTIGOLEJEUNEA) 5

5. Innovations normally single; perianth, when mature, without perceptible secondary plicae ..... Sectio AURICULATAE
5. Innovations paired, soon again floriferous (the secondary gynoecia with 1-2 innovations); perianths at maturity pluriplicate, at least with weak accessory plicae ..... Sectio NIGRAE

6. Perianth sharply trigonous, with keels ± toothed; branches all of the *Lejeunea*-type; oil bodies 2-4 per cell ..... *Thysananthus*
6. Perianth 8-12-carinate, even when young, the keels smooth; vegetative branches of the *Frullania*-type ..... *Ptychanthus*

7. Lobules with 2 marginal teeth; cells with coarse, subconfluent trigones; perianth erostrate, with 5(-7) weak plicae above, which are inflated and dilated, extending upward; leaves with strongly deflexed apices; stems with 20-36 rows of cortical cells ..... *Schiffneriolejeunea*
7. Lobules with a single apical tooth; leaf cells with trigones coarse but not subconfluent, with intermediate thickenings; perianths rostrate, the carinae represented above by 3-5 faint ridges near the apex, thus practically ecarinate; leaves with apices not strongly deflexed; stems with ca. 16-18 rows of cortical cells ..... *Phragmilejeunea*

8. Without subfloral innovations; often with ascending branches bearing caducous leaves; ♀ bracts isomorphous, the lobules large and often approaching the lobes in size, the keel not lamellate; leaves with lobules bearing 2-9 teeth ..... *Ptychocoleus*
8. With 1-2 subfloral innovations constantly present; without asexual reproduction; ♀ bracts with keel lamellate or ♀ bracts usually dimorphous, the lobule in any case usually rather small and much shorter than the lobe (*Brachiolejeunea*) 9

9. ♀ Bracts isomorphous: both with keel sharply winged; leaves with lobule 4-9-dentate ..... Subgenus BRACHIOLEJEUNEA
9. ♀ Bracts usually dimorphous: one with lobule well developed, the other with it vestigial or wholly absent; bracts with keel unwinged; leaves with lobules 1-3(rarely 4)-dentate ..... Subgenus TROCHOLEJEUNEA

DIAGNOSES AND SYNONYMY.

1. *Mastigolejeunea* sectio **Auriculatae** sect. nov. Perianthia pyriformia, triplicata, uno latere innovata (interdum geminatim innovata). TYPE: *M. auriculata* (Wils. & Hook.) Schiffn., the generitype of *Mastigolejeunea*.

2. *Mastigolejeunea* sectio **Nigrae** sect. nov. Perianthium e bracteis emergens, claviformi-cylindricum, carinis primariis 3 carinis secondariis munitis, innovationibus subfloralibus 1-2 muniti. TYPES: *M. nigra* St.; also *M. rhodesica* (V. Bergh.) Jones.

3. *Mastigolejeunea* subgenus **Tuzibeanthus** (Hatt.) comb. nov. *Tuzibeanthus* Hatt., Biosphaera 1(1): 5, 7. 1947. Type: **Mastigolejeunea porelloides** (Hatt.) comb. nov. *Tuzibeanthus porelloides* Hatt., *loc. cit.*

4. *Brachiolejeunea* subgenus **Trocholejeunea** (Schiffn.) comb. nov. *Trocholejeunea* Schiffn., Ann. Bryol. 5: 160: 1932.

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STUDIES ON LICHENIZED FUNGI[1]

VERNON AHMADJIAN[2]

Successful efforts of many investigators (Thomas, 1939; Zehnder, 1949; Tomaselli, 1958; Hale, 1958; Henriksson, 1958; and others) indicate that isolation and cultivation of lichenized fungi can now, in most cases, be readily accomplished in the laboratory using basically similar techniques and materials to those used in other phases of mycological study. Findings by these workers reveal also that the fungal component (mycobiont) of lichens, with regard to cultural behavior and requirements, generally differs little from other free-living fungi. Such studies have done much to bring about a clearer, more factual understanding of the lichen association. It is hoped that the following report will contribute to this understanding.

The method of isolation for most lichen fungi used in this investigation was as follows: Freshly collected lichen thalli with ascocarps were washed in cold, running tap water for 20-30 minutes. Individual lichen apothecia, perithecia, or fragments of lichen which had many ascocarps[3] were then quickly affixed, by means of vaseline, to an upper half of a petri plate cover; the top half of the plate was then inverted over the bottom half which contained a layer of soil-extract nutrient agar (Bold, 1942; pH of the extract used in this study = 6.1). As the ascocarps dried, spores were forceably discharged, usually in abundance, onto the underlying agar surface. Following germination of spores, pieces of agar substrate which contained one or many spores were punched out and transferred to culture tubes with organic nutrient agar.

Speed of discharge and germination of lichen spores were quite variable and dependent on the lichen species. Species of *Cladonia* and *Baeomyces* studied emitted masses of spores almost immediately after drying commenced; germination of spores at 26°C. was rapid also, occurring within 2-4 hours after discharge. Other lichens listed emitted varying numbers of spores commencing several hours after fruiting bodies were attached to the plate, but germination was somewhat slower, ranging from 10 to 24 hours after discharge. Unsuccessful mycobiont isolation attempts were made with the following lichens: *Bacidia chlorococca, Calicium viride* (spores obtained in suspension), *Haematomma ventosum, Lasallia*

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[3] Care was taken to insure that all ascocarps on the fragment belonged to one lichen type.

papulosa, Lobaria pulmonaria, Peltigera canina, Rhizocarpon alpinum, and *Rhizocarpon geographicum.* In all cases, unsuccessful attempts resulted from failure of spore germination. Attempts were made to isolate mycobionts of *Bacidia chlorococca* and *Lobaria pulmonaria* by means of hyphal cultures, *i.e.,* hyphal fragments around phycobiont cells in the first lichen and hyphal tissue from medullary region of the second lichen. Although fungi did develop from such isolations, there was no certainty that these cultures represented mycobionts and not contaminant fungi found on or within the lichen thallus.

Separated mycobionts whose spores germinated on soil-extract agar were cultured further (polyspore cultures in all but two instances) in test tubes which contained either mycological agar (Difco, pH = 7.0) or malt extract-yeast extract agar (Lilly & Barnett, 1951, p. 425, pH = 6.3). Cultures were maintained in duplicate in complete darkness at 18°C. and 26°C. Comparative growth and morphological observations were made daily up to a period of two months.

Following is a list of lichens from which mycobionts used in this investigation were isolated. Cultural characteristics and observations are given for the various mycobiont isolates. Lichen specimens and stock cultures of isolated mycobionts are being maintained in the Clark University Herbarium. Unless otherwise indicated, characteristics of each listed mycobiont have been described from cultures grown in test tubes which contained malt extract-yeast extract agar at 18°C. Spore isolation and germination plates were kept at 26°C. Many of the mycobionts were cultured also for long periods of time (8-12 months) in 500 ml. Erlenmeyer flasks with 200 ml. of malt extract-yeast extract medium to obtain giant colonies. Few visible differences in morphological characteristics other than size were noted between colonies grown in flasks and those in test tubes.

1. *Acarospora fuscata* (Nyl.) Arn. Twelve specimens growing on rock surfaces were collected from the following localities: Auburn, Mass. (4 specimens); Berlin, Mass., Holden, Mass., North Brookfield, Mass. (2 specimens), Oxford, Mass., Worcester, Mass., Mt. Monadnock, N. H. (2 specimens collected near summit of mountain, alt. 1000 m.). In addition, the mycobiont from a specimen collected in Auburn, Mass., was cultured by means of hyphal fragments growing around cells of the *Trebouxia* phycobiont. In this case, there was little doubt that the fungus obtained in culture was the mycobiont, since it compared well with other mycobionts of this group both in morphology and in production of red pigment.—Spores from this lichen species were discharged in packets, some of which contained a hundred or more spores. Growth was rapid, some spore packets forming macroscopically visible colonies (2-3 mm. in diameter) within 10 days. All investigated specimens of *Acarospora* species produced a bright

red, water-soluble pigment in both solid and liquid media. The pigment is described further on in this paper.

2. *Acarospora smaragdula* (Wahl.) Th.Fr. This lichen is also referable to *Acarospora veronensis* Mass., which according to Weber (*in lit.*) is synonymous with *A. smaragdula*. Two specimens collected on rock from Auburn and North Brookfield, Mass.—Spores were discharged in packets containing numerous spores. Growth was rapid and colonies of the mycobionts produced a dark red, water-soluble pigment which seemed in its early stages of production to be somewhat similar in appearance to the pigment produced by *A. fuscata*, but in later stages changed to a dark red (maroon to brownish-red) color. Mycobiont colonies were often colored yellow in certain parts as well as red. Older cultures of mycobionts showed abundant masses of yellow crystals on both fungal colonies and surrounding agar medium.

3. *Baeomyces roseus* Pers. Two specimens collected on roadside banks from Princeton and Whitinsville, Mass.—Germination of spores and initial growth of mycobiont were very rapid. Growth, however, after 6-12 weeks slowed somewhat. Fungal colonies after an initial white mycelial stage became flesh-colored in older colonies. Color of the mycobiont colony was identical to that of the lichen apothecium. Hyphal cells of this mycobiont were filled with abundant oil droplets, a condition found also in the composite plant (Zukal, 1895, p. 1372).

4. *Cladonia cristatella* Tuck. Four specimens collected from Lime Rock, Conn. (in open field), Holden, Mass. (on roadside bank), Millbury, Mass. (in open field), and Mt. Monadnock, N. H. (among rocks near summit of mountain, alt. 1000 m.).—Masses of spores were discharged, followed by rapid germination and initial growth. Growth, however, slowed somewhat as colonies aged. As the mycobionts became older, color of the entire colony or portions of it changed from pure white to bright yellow to red to reddish-brown.

5. *Cladonia floerkeana* (Fr.) Flörke. Specimen collected from stone wall along a road in Auburn, Mass. (det. M. E. Hale).—Masses of spores were discharged, followed by rapid germination and initial growth. Colonies were white, then a bright yellow in color. Growth virtually stopped after colony size reached 1-2 mm. in diameter.

6. *Cladonia pleurota* (Flörke) Schaer. Specimen collected on a roadside bank in Whitinsville, Mass.—Masses of spores were discharged, followed by rapid germination and initial growth. Mycobiont colonies changed in color from white to reddish to dark brown. Portions of older colonies showed a dark blue color and sometimes produced a dark blue water-soluble pigment which diffused throughout the agar. Droplets of a dark red exudate were often found on the colony surface; microscopic examination of hyphal branches of certain sections of the colony showed a violet pigmentation which was not visible macroscopically. Six-month old colonies (3.0 cm. in diameter) showed distinct concentric rings of growth.

7. *Cladonia subcariosa* Nyl. Specimen collected on roadside bank in Whitinsville, Mass.—Masses of spores were discharged, followed by rapid germination and initial growth. Colonies as they matured changed from white to yellow to reddish to brown. It is interesting to note that Thomas (1939) also found a yellow and sometimes brownish color in his *Cladonia* spp. mycobionts.

8. *Graphis scripta* (L.) Ach. Specimen collected on bark from Blue Ridge Mts., Va. (det. M. Wirth).—Germination of spores and growth of the mycobiont colony were rapid. Colonies changed from white to brown to reddish-brown and were generally covered with droplets of a brown exudate. Portions of the colony of some cultures showed a distinct blue color.

9. *Icmadophila ericetorum* (L.) Zahl. Specimen collected at Vassivarto, Sweden (Lapland).—Numerous spores were emitted, but only a small percentage germinated. Growth of germ tubes and subsequent growth of colonies were extremely slow. Colonies were buff-orange, identical in color to lichen apothecium. Several cultures of the mycobiont were obtained in which *Coccomyxa* algae developed and overgrew the mycobiont. Such algal colonies undoubtedly developed from cells (hymenial gonidia) discharged with the fungal spores, a fact also observed by Thomas (1939, p. 107) with the specimen of *I. ericetorum* used in his investigation.

10. *Lecanora chlarotera* Nyl. Specimen collected on *Betula* sp. from Princeton, Mass. (det. W. Weber).—Spore germination and later growth were very slow. The mycobiont grew only on mycological agar (pH = 7.0). Colonies were initially light brown and then turned bright yellow; they produced a water-soluble, dark brown pigment which diffused throughout the medium.

11. *Lecidea* sp. Specimen collected on the ground from Ross Island, Antarctica.—Monospore isolate developed extremely slowly; mycobiont size reached 1-2 mm. in diameter only after 9-12 months at 8°C. After several years in culture, the growth rate became faster, and growth resulted fairly well even at a temperature of 18°C. Colonies were initially white, then yellow in parts, and then light brown.

12. *Lecidea crustulata* (Ach.) Spreng. Specimen collected on rock from summit of Mt. Monadnock, N. H., alt. 1000 m. (det. W. Weber).—Scattered spore discharge was followed by slow germination and growth of the fungus; germ tubes were tinted blue. Mycobiont colonies were at first white, then pink or light brown; parts of a colony were often yellow.

13. *Parmelia conspersa* (Ach.) Ach. Specimen collected on stone from Oxford, Mass.—Numerous spores were discharged, but only a small percentage germinated. Growth of germ tubes and subsequent colony growth were extremely slow. Colonies on mycological agar were at first white, then turned dark brown to gray or black, in some instances secreting a water-soluble, brown pigment. Colonies transferred to malt extract-yeast extract agar showed the same brown-black color, without diffusible pigment, however.

14. *Physcia orbicularis* var. *rubropulchra* Degel. Specimen collected on bark from Princeton, Mass.—Numerous spores were discharged, and a high percentage germinated. Monospore culture of mycobiont grew extremely slowly, colony size reaching 1-2 mm. in 9 months. Colonies were orange.

15. *Physcia stellaris* (L.) Nyl. Specimen collected on bark from Sutton, Mass.—Numerous spores were discharged and germinated readily; growth, however, was quite slow. Colonies were frosty-white and later turned dark brown in some portions.

16. *Ramalina fastigiata* (Pers.) Ach. Specimen collected on bark from Brookfield, Mass.—Numerous spores were discharged, and many germinated.

Growth was slow. Colonies formed changed color from white to reddish-brown.

17. *Sarcogyne simplex* (Dav.) Nyl. Specimen collected on rock from Holden, Mass.—Spores were discharged in packets, similar to those of *Acarospora* spp. Growth was very rapid; colonies formed were white, sometimes light brown in older cultures; cultures also frequently showed a pinkish hue.

18. *Stereocaulon dactylophyllum* var. *flabellatum* (Frey) M. Lamb. Specimen collected on rock from summit of Mt. Monadnock, N. H., alt. 1000 m. (det. I. M. Lamb).—Scattered spore discharge was followed by slow germination and growth. Colonies were pure white at first, then yellow, then reddish-brown, quite similar to the *Cladonia* spp. in morphology and coloration.

It is evident from the above descriptions of fungal cultures that the mycobionts were as varied and diverse as the lichens from which they were isolated. These mycobionts, however, did have common traits in that colonies were always compact, hard in consistency, and usually elevated above the agar surface. Morphological differentiation of mycobiont colonies into structures comparable to lichen thalli (*i.e.*, cortex, medulla, and rhizoids) was not seen in microtome sections of 2-month-old colonies, although in some colonies banding and pigmentation of groups of hyphal branches suggested beginnings of such a structural differentiation. There was, however, no pseudoparenchymatous tissue in any of the cultures. With the exception of *Acarospora* species, none of the mycobiont colonies resembled the composite plants in anything but pigmentation. In several cultures of *Acarospora* mycobionts colonies showed a gross similarity to the lichen thallus, *i.e.* fungal colonies were small, rounded discs with a darkened depression corresponding to the apothecium in the middle of each disc. Microscopic examination failed to show reproductive tissue. None of the isolated mycobionts showed reproductive structures (*e.g.*, conidia, oidia) of any kind.

Growth rates and conditions for optimal growth of the mycobionts varied widely. Because of extreme slowness of growth on media and under conditions used in this investigation, little cultural information, apart from initial growth and development, could be obtained from mycobionts isolated from the following: *Cladonia floerkeana, Icmadophila ericetorum, Lecanora chlarotera, Lecidea* sp., *Parmelia conspersa, Physcia orbicularis* var. *rubropulchra, Physcia stellaris.*

Other mycobionts studied generally grew much faster on malt extract-yeast extract agar as compared with mycological agar. Optimal growth of mycobionts on malt extract-yeast extract agar medium of varying pH ranged between pH 4.5 and 6.5. With re-

gard to temperature, optimal growth of mycobionts on malt extract-yeast extract agar ranged between 18 and 26°C., the majority growing better at temperatures close to 20°C. Thomas (1939) found generally the same range of pH optima for his mycobionts; the temperature range for his mycobionts was from 15 to 21°C. Among the mycobionts, the most rapid growth rate was that of *Sarcogyne simplex*, followed closely by *Acarospora* species (fig. 1) (see also Hale, 1958, and Tomaselli, 1958).

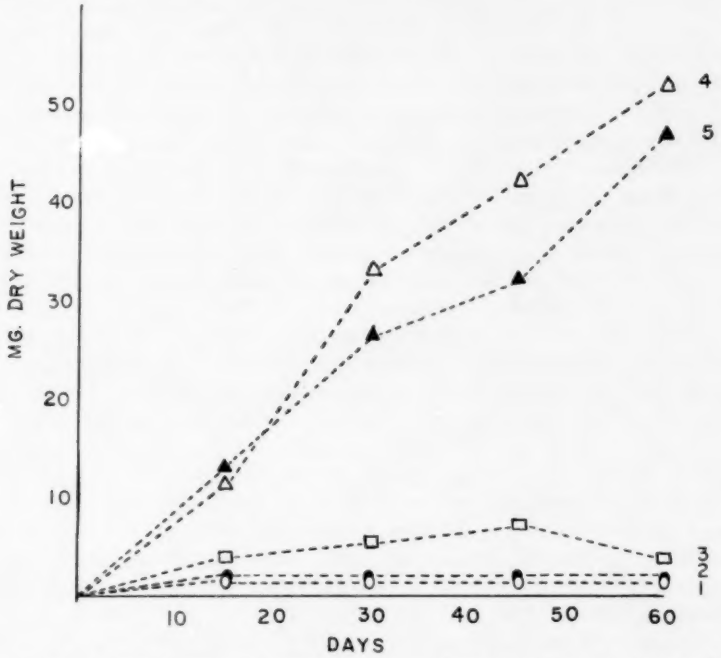

FIG. 1. Growth curves of mycobiont from *Acarospora fuscata*, Auburn 1, in glucose-asparagine vitamin supplement media at 18°C. Each point represents average dry weight of mycelium from eight 125 ml. Erlenmeyer flasks with 25 ml. of medium per flask. Mycobiont was first cultured in a vitamin free medium for two weeks before being used as inoculum. No. 1 represents the growth in a control without added vitamins; 2, thiamine added; 3, biotin added; 4, thiamine and biotin added; 5, thiamine, biotin, inositol and pyridoxine added.

In a growth experiment using mycobionts of lichens *Acarospora fuscata* (Auburn 1), *A. smaragdula* (Auburn 7), *Baeomyces roseus* (Princeton), *Cladonia cristatella* (Millbury), and *Sarcogyne simplex*, it was found that the growth rate was much more rapid under

relatively reduced conditions. In this experiment, fungi were macerated in a blender and equal aliquots (2 ml.) of hyphal suspensions were pipetted into 250 ml. Erlenmeyer flasks containing 50 ml. of the following media (per liter of distilled water): 1. Dextrose (20 g.), yeast extract (2 g.), sodium thioglycollate (2 g.); pH = 6.6. 2. Control of no. 1, without sodium thioglycollate; pH = 6.2. 3. Same as no. 1, with the addition of 0.1% agar; pH = 6.5. 4. Control of no. 3, without sodium thioglycollate; pH = 6.0. The most rapid and strongest growth of all five mycobionts occurred in medium no. 4, followed by media no. 2, 1, and 3, respectively. Apparently, sodium thioglycollate in media 1 and 3 provided reduced conditions beyond the point of optimal growth, since growth generally was much slower than in media 4 and 2. A possibility that the agar might have contributed some growth factor in medium 4 was discounted when this same phenomenon of rapid growth was observed using a highly purified agar. Pigment production of all mycobionts (similar to pigments formed on solid medium) occurred much more rapidly in medium no. 4, a fact undoubtedly largely correlated with the strong development of the mycobionts in such a relatively reduced medium.

Mycobionts used in this investigation grew very poorly on media lacking growth factors. The basic medium used was as follows (see Lilly & Barnett, 1951, p. 427): dextrose, 10 g.; ammonium tartrate, 2 g.; KH_2PO_4, 1 g.; $MgSO_4 \cdot 7H_2O$, 0.5 g.; $Fe(NO_3)_3 \cdot 9H_2O$, 0.2 mg.; $ZnSO_4 \cdot 7H_2O$, 0.2 mg.; $MnSO_4 \cdot 4H_2O$, 0.1 mg.; $CaCl_2$, 0.2 g.; distilled water, 1 liter; initial pH = 5.5. Modifications of this medium using mannitol for the carbohydrate source and asparagine as the nitrogen source also failed to support substantial growth of the mycobionts (*i.e.*, more than 2 mg. dry weight of fungal tissue after 11 weeks). Addition of vitamins to the above medium considerably influenced growth of ten mycobionts (*viz.*, *Acarospora fuscata*, Auburn 1,3,4,7; *A. smaragdula*, Auburn 7, N. Brookfield; *Baeomyces roseus*, Princeton; *Cladonia cristatella*, Holden; *C. pleurota*; and *Sarcogyne simplex*). Using the basic method described by Lilly and Barnett (1951, p. 432), equal aliquots (1 ml.) of hyphal suspensions of mycobionts were inoculated into 125 ml. Erlenmeyer flasks containing 15 ml. of the medium described above (with glucose and asparagine) plus vitamins. Media used were as follows: 1. Basal medium (vitamin free). 2. Plus thiamine (100 µg./liter). 3. Plus biotin (5 µg./liter). 4. Plus thiamine and biotin. 5. Plus thiamine, biotin, inositol (5 µg./liter) and pyridoxine (100 µg./liter); pH values of the media were between 4.6 and 4.7. Mycobionts were cultured in basal medium for two weeks and then washed with distilled water before maceration.

Cultures were maintained at 18°C., and dry weight measurements were made at periodic intervals up to 11 weeks. Results of the vitamin studies can be summarized as follows: None of the mycobionts showed appreciable growth after 11 weeks in vitamin-free medium; growth was also quite poor in medium containing only thiamine (no. 2). All mycobionts showed strong growth in media 4 and 5 and, depending on the mycobionts, varying amounts of growth in medium 3. There was no doubt that growth of the mycobionts, if not fully dependent on, was greatly enhanced by addition of vitamins, especially biotin and thiamine. (See also Hale, 1958.)

Many of the mycobionts produced highly pigmented compounds. One of these pigments, namely, the one produced by *Acarospora fuscata*, was studied in greater detail than the others. The red, water-soluble pigment formed by *A. fuscata* mycobionts was first noticed being produced by 2-week-old colonies growing on the original soil-extract agar isolation plate. Diffusion of the red pigment through the agar was clearly visible. All specimens of *A. fuscata* and both specimens of *A. smaragdula* produced this pigment but in varying quantities and in various shades, from light purple-red to bright red. Such a change in color was shown to result from the concentration of pigment, the purple-red color being caused by the smallest concentration of pigment. Microscopic examination revealed that the pigment was produced within older hyphal cells. Formation and nature of this single pigment was influenced by changes of CO_2 concentration, temperature, pH, and vitamins. Color changes of this pigment under different conditions varied from light purple to red to yellow to brown. Colonies grown in cotton-stoppered 500 ml. Erlenmeyer flasks with 100 ml. of malt extract-yeast extract agar medium after several weeks' growth became reddish and produced the bright red pigment which diffused into the surrounding medium. After one to two months, colonies became yellowish to light brown and the diffused pigment dark brown. It appeared that the pigment had been oxidized. Similar cultures grown under reduced atmospheric conditions (*i.e.*, CO_2) showed no color change, except for an intensification of the red color to a much darker hue, even after four months' growth. Pigment formation occurred more readily at 8-19° C. than at higher temperatures even if growth was stronger at the higher temperatures; pigment formed at temperatures of 26-28° C. was initially brown rather than red. The fungal colonies were also brown although the reddish pigment was still visible in a few hyphal cells. It is easy to see how such a red pigment could be responsible for the brown color of the lichen thallus when one considers that these lichens grow on rock surfaces, the temperature

of which must be very high during warm weather months. This pigment formed earliest at pH 5.2 (using several different liquid media, such as malt extract-yeast extract broth, phyton-dextrose broth, mycological broth and glucose-asparagine-biotin medium. This pH figure of 5.2, however, was correlated with the optimal growth level of the mycobiont.

With regard to vitamins, biotin played an important rôle in the early production of the red pigment. In a vitamin-series experiment with *Acarospora fuscata*, Auburn 1, (*fig.* 2) it was noted clearly that within ten days the basal medium which contained biotin alone, in almost all flasks, had turned light purple-red and a few days later bright red. The other four media were still colorless, even though growth was much stronger on media which contained both thiamine and biotin and media with all four vitamins. After 15-30 days, media 4 and 5 began slowly to turn pale purple-red.[4] With other *Acarospora fuscata* specimens and *A. smaragdula*, such a phenomenon was not as clear cut; the pigment, in these cases, varied from red to brownish-yellow and in some instances appeared first in media 4 or 5.

Absorption spectra of the isolated and purified pigment of *Acarospora fuscata* (Auburn 7) showed an absorption maximum at 540 mμ. The pigment was extracted from malt extract-yeast extract broth by ethyl acetate; this solvent extracted more of the pure pigment, albeit giving a smaller yield than the various alcohols. Once extracted, the pigment was chromatographed, dried, and redissolved in ethanol. This purified and dried red pigment within several hours turned yellow at room temperature, while another portion of the pigment kept in a refrigerator remained bright red. The yellow color of the pigment showed a shift in the absorption peak to 460 mμ.

The several forms and behavior of this pigment under different laboratory conditions would explain the varying intensities of brown color of this lichen, as well as the reddish or yellowish-brown color found frequently in naturally occurring thalli of this species (Howard, 1950; Magnusson, 1956). Color variations and intensities must be influenced by a microclimate surrounding the individual lichen thallus. This same bright red pigment could be seen in portions of the hymenium and hypothecium of sectioned thalli of the composite plant *A. fuscata*. The lichen cortical layer was brown, which indicated perhaps an oxidation of the red pigment.

[4] Additions of methionine (5 μg./l.), lipoic acid (100 μg./l.), and cysteine (100 μg./l.) to all 5 media of the vitamin series did not alter the described pattern of pigment formation. Niacin (100 μg./l.) and riboflavin (100 μg./l.), however, had actions similar to biotin regarding rate of pigment production.

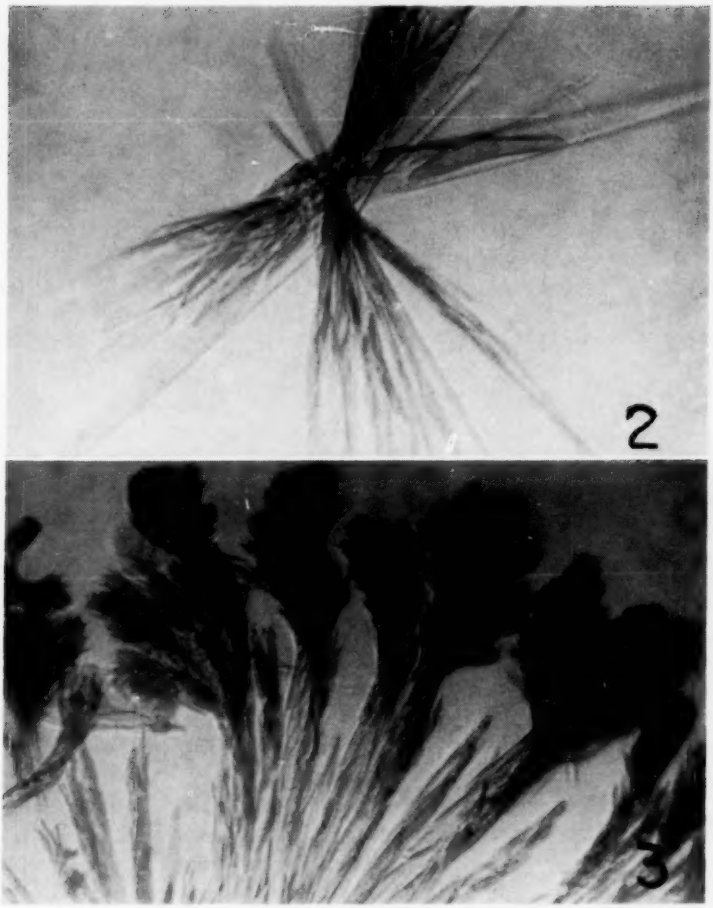

FIG. 2. Crystals produced by mycobiont of *Acarospora smaragdula*. Recrystallized from glycerol-ethanol-water (1:1:1). × 450. FIG. 3. Crystals produced by mycobiont of *Acarospora smaragdula*. Recrystallized from glycerol-ethanol-water (1:1:1). Feathery configuration at ends of crystals caused by rapid evaporation of solvent. × 450.

In addition to a bright red pigment, which seemed similar to one produced by *Acarospora fuscata*, the two specimens of *A. smaragdula* formed several interesting compounds. Polygonal-like, laminated crystals, insoluble in water and acetone, were found frequently on and among the mycobiont hyphae on both solid and

liquid media. Occasionally, small "dumbbell-shaped" crystals, likewise insoluble in water and acetone, were seen on and among the hyphae on liquid and solid media. As the mycobiont colonies on malt extract-yeast extract agar became older, bright yellow plate- or saucer-like structures of varying sizes (up to 2-3 mm. in diameter) appeared on the agar surface surrounding the fungal colony and in areas of greatest pigment concentration. Such structures were easily detached from the agar surface and microscopically their constituent particles showed little definite configuration. These yellow saucers were insoluble in water and readily soluble in acetone, chloroform, and ether. Acetone solutions of such structures were easily recrystallized on a glass slide using glycerol-ethanol-water (1:1:1) or glycerol-acetic acid (1:3) (Asahina & Shibata, 1954). The resultant yellow crystals (*fig. 2, 3*) showed a resemblance to usnic acid. This compound whose biological activity, color reaction with $FeCl_3$, Rf value, and absorption spectrum were similar to usnic acid has been briefly characterized earlier (Ahmadjian & Reynolds, 1961). In all tests there was not a precise, exact correlation between the known usnic acid and the unknown compound, a fact undoubtedly resulting from the impurity of the latter compound. Yellow plate-like structures did not appear on mycological agar or dextrose-yeast extract agar. Thomas (1939, p. 145, pl. 5, fig. 3) noted that his isolated mycobiont of *Candelariella vitellina* produced similar structures on the fungal colony and surrounding agar surface. This compound, which was easily recrystallized, he called stictaurin (= pulvic anhydride, according to Asahina & Shibata, 1954). Thomas noted also that such structures were formed only on malt agar.

One limiting factor in the physiological study of lichen components has been the widespread view that such organisms grow much too slowly. Such a view is not wholly true. Many isolated lichen fungi grow well in culture, the growth rate of some mycobionts equaling that of many free-living fungi (see also Hale, 1958). Application of modern mycological techniques would certainly yield much valuable information on lichenized fungi and on the nature of the lichen association.

Grateful acknowledgment is made to Mrs. J. P. Roche, for technical assistance; Dr. William A. Weber, Dr. Mason E. Hale, and Dr. I. Mackenzie Lamb, for identification or verification of specimens; Mr. Matthew Connors, for information on the purified pigment; Mr. Thomas Barry, for information on the absorption spectrum of the unknown compound produced by *A. smaragdula* mycobiont; and Miss Harriet E. Donais, for information on the correlation between pH, growth and pigment production of the *A. fuscata* mycobiont.

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BRYOPHYTES COLLECTED DURING THE ARCTIC FIELD TRIP OF THE NINTH INTERNATIONAL BOTANICAL CONGRESS

HERMAN PERSSON AND KJELD HOLMEN[1]

From a bryological point of view arctic Canada is far from well known. Best known is Ellesmere, owing to the rich collections of H. SIMMONS (Bryhn, 1906-07) and R. M. SCHUSTER (Schuster, Steere & Thomson, 1960). But also from Cornwallis Island we have a good list of species because of the activity of W. B. SCHOFIELD (Steere, 1951). Other reports from this large area may best be characterized as comparatively incomplete. On the bryological investigations see further Steere (1939, 1947, 1954, 1955), Schuster (1951), and Lepage (1953). The contributions in the present paper may also be said to be fragmentary, as they are based on

[1] Riksmuseets Paleobotaniska Avdelning, Stockholm 50, Sweden; Universitetets botaniske Museum, Gothersgade 130, København, Denmark.

casual collections made by participants of the Arctic Field Trip preceding the Ninth International Botanical Congress, 1959—none of them bryologists and none making an attempt to collect all the bryophytes of the stations visited.

We have received material from Dr. O. HEDBERG, Uppsala; Dr. E. HULTÉN, Stockholm; Dr. J. T. K. KUKKONEN, Finland; Dr. I. K. MORTON, Ghana; Dr. T. SØRENSEN, Copenhagen; and Dr. W. A. WEBER, Boulder, Colo. We are most grateful to these botanists, who so kindly have handed over their material to us. The material consisted of a number of regular moss collections, richly supplemented by specimens removed from collections of vascular plants made by the same botanists (the collections made by Dr. Kukkonen and Dr. Morton consist exclusively of such segregated specimens). Dr. Sørensen's collections are incorporated in the herbarium of Botanisk Museum, Copenhagen; the others are at the Naturhistoriska Riksmuseum, Stockholm.

The Arctic Field Trip, led by Dr. A. E. PORSILD of Ottawa, visited the seven localities enumerated below. We have received samples from all seven. The places have all been visited previously by botanists, and from most of them bryophytes have been reported, but only very few from Victoria Island and Knob Lake. The localities are situated far from each other and in different geological provinces; this makes possible a comparison of the various bryofloras. Such a comparison may be of interest, as some of the localities are arctic and others subarctic; besides, in some of the localities the subsoil is Paleozoic, in the others Precambrian.

In the list below the collectors names are abbreviated as follows: H (Hultén), He (Hedberg), K (Kukkonen), M (Morton), S (Sørensen), and W (Weber).

LOCALITIES

Cornwallis I.: Resolute (74°43′ N., 94°59′ W.). Subsoil: Paleozoic schists. Aug. 12-13.

Victoria I.: Cambridge Bay (69°07′ N., 104°47′ D.). Subsoil: Paleozoic schists. Aug. 13.

Southampton I.: Coral Harbour (64°09′ N., 83°05′ W.). Subsoil: Both Paleozoic and Precambrian. Aug. 15.

Baffin I.: Frobisher Bay (63°45′ N., 68°34′ W.). Subsoil: Precambrian. Aug. 10-11.

Labrador: Ungava Bay, Fort Chimo (58°09′ N., 68°18′ W.). Subsoil: Precambrian. Aug. 18. Hudson Bay, Great Whale River (55°17′ N., 77°47′ W.). Subsoil: Precambrian. Aug. 8. Schefferville, Knob Lake (54°48′ N., 66°49′ W.). Subsoil: Precambrian. Aug. 9.

HEPATICAE

Barbilophozia barbata (Schmid.) Loeske. Coral Harbour (M), Great Whale R. (W,K).

B. hatcheri (Evs.) Loeske. Great Whale R. (M,S).

B. lycopodioides (Wallr.) Loeske. Great Whale R. (H).
Blepharostoma trichophyllum (L.) Dum. Cambridge Bay (H), Coral Harbour (S), Frobisher Bay (H), Fort Chimo (H.)
Cephalozia ambigua Mass. Frobisher Bay (H), Fort Chimo (H).
C. media Lindb. Fort Chimo (H).
C. pleniceps (Aust.) Lindb. Knob L. (H).
Cephaloziella arctica Bryhn & Douin. Cambridge Bay (H), Frobisher Bay (H), Great Whale R. (K,S,W).
C. divaricata (Fr.) Schiffn. Fort Chimo (H).
C. subdentata Warnst. Fort Chimo (S).
Chandonanthus setiformis (Ehrh.) Mitt. Frobisher Bay (W), Fort Chimo (H).
Cladopodiella fluitans (Nees) Spr. Fort Chimo (H), Knob L. (S,K).
Gymnocolea inflata (Huds.) Dum. Great Whale R. (S). Var. *acutiloba* (Kaal.) S. Arn. Fort Chimo (S).
Gymnomitrion corallioides Nees. Frobisher Bay (W).
Jungermannia cf. *atrovirens* Dum. Frobisher Bay (H).
Leiocolea badensis (Gottsche) Jörg. Frobisher Bay (H).
L. heterocolpos (Thed.) Buch. Cambridge Bay (H), Frobisher Bay (H).
Lophozia groenlandica (Nees) Bryhn. Coral Harbour (S), Frobisher Bay (H,M), Great Whale R. (S).
L. latifolia Schust. Coral Harbour (H), Great Whale R. (M).
L. ventricosa (Dicks.) Dum. Fort Chimo (H).
Marchantia alpestris Nees. Cambridge Bay (H,S), Coral Harbour (H).
Marsupella arctica (Berggr.) Bryhn & Kaal. Coral Harbour (M).
Mylia anomala (Hook.) S. F. Gray. Fort Chimo (S), Knob Lake (S).
Odontoschisma elongatum (Lindb.) Evs. Fort Chimo (H,M,S), Knob L. (K,M).
O. macounii (Aust.) Underw. Frobisher Bay (H).
Orthocaulis binsteadii (Kaal.) Buch. Coral Harbour (He), Frobisher Bay (He,S), Great Whale R. (H).
O. kunzeanus (Hüb.) Buch. Knob L. (K).
O. quadrilobus var. *heterophyllus* Bryhn & Kaal. Cambridge Bay (H), Frobisher Bay (H).
Plagiochila arctica Bryhn & Kaal. Cambridge Bay (K), Frobisher Bay (H).
Preissia quadrata (Scop.) Nees. Coral Harbour (S).
Ptilidium ciliare (L.) Hampe. Coral Harbour (M), Frobisher Bay (H,K), Great Whale R. (K,M,S), Knob L. (S).
Riccardia pinguis (L.) S. F. Gray. Resolute (H), Cambridge Bay (S), Coral Harbour (H), Fort Chimo (S).
Saccobasis polita (Nees) Buch. Fort Chimo (H).
Sauteria alpina Nees. Coral Harbour (S).
Scapania curta (Mart.) Dum. Frobisher Bay (M).
S. degenii Schiffn. Great Whale R. (M).
S. irrigua (Nees) Dum. Knob L. (K).
S. hyperborea Jörg. Great Whale R. (W).
S. obcordata (Berggr.) S. Arn. Great Whale R. (M).
S. obscura (Arn. & Jens.) Schiffn. Frobisher Bay (S).
S. paludicola Loeske & K. M. Great Whale R. (K,S), Knob L. (H,K).
Sphenolobus minutus (Cr.) St. Frobisher Bay (H,K,S), Fort Chimo (H), Great Whale R. (S).
Tritomaria quinquedentata (Huds.) Buch. Great Whale R. (K,S,W). Var. *turgida* (Lindb.) H. Weim.: Frobisher Bay (K), Fort Chimo (M).
T. heterophylla Schust. Coral Harbour (S).

SPHAGNALES

Sphagnum compactum DC. Fort Chimo (H).
S. fimbriatum Wils. Coral Harbour (He).
S. lenense H. Lindb. Frobisher Bay (He).
S. nemoreum Scop. Fort Chimo (H).
S. robustum (Russ.) Röll. Fort Chimo (He), Knob Lake (S).
S. rubellum Wils. Coral Harbour (He), Frobisher Bay (He), Fort Chimo (He), Great Whale R. (S), Knob L. (K,S).
S. subfulvum Sjörs. Fort Chimo (H,S).
S. tenellum Pers. Fort Chimo (H).
S. teres (Schimp.) Angstr. Coral Harbour (He).
S. warnstorfianum DuRietz. Fort Chimo (H,S).

BRYALES

Abietinella abietina (Hedw.) Fl. Cambridge Bay (He), Frobisher Bay (M).
Amblystegium varium (Hedw.) Lindb. Resolute (He), Cambridge Bay (He,S), Coral Harbour (M).
Aulacomnium acuminatum (Lindb. & Arn.) Par. Coral Harbour (W).
A. palustre (Hedw.) Schwaegr. Cambridge Bay (He), Coral Harbour (He,S), Frobisher Bay (He), Fort Chimo (He,S), Great Whale R. (M,S), Knob L. (H,K).
A. turgidum (Wg.) Schwaegr. Cambridge Bay (W), Coral Harbour (M), Frobisher Bay (H,K,S), Great Whale R. (H,S).
Barbula icmadophila Schimp. Resolute (He,K,M), Coral Harbour (M).
Blindia acuta (Hedw.) Br. & Schimp. Frobisher Bay (S).
Brachythecium groenlandicum (C. Jens.) Perss. & Holm. Frobisher Bay (H).
B. turgidum (Hn.) Kindb. Cambridge Bay (H,He), Coral Harbour (H,K, S,W), Fort Chimo (S).
Bryoerythrophyllum recurvirostrum (Hedw.) Chen. Resolute (He,M,S), Cambridge Bay (H), Coral Harbour (H,S).
Bryum argenteum Hedw. Cambridge Bay (H), Coral Harbour (S).
B. calophyllum R. Br. Resolute (H,S), Coral Harbour (M,S), Frobisher Bay (S).
B. cirratum Hoppe & Hornsch. Knob Lake (H).
B. crispulum Hampe. Resolute (K), Coral Harbour (S), Great Whale R. (S).
B. inclinatum (Brid.) Br. & Schimp. Fort Chimo (M).
B. ovatum Jur. Cambridge Bay (K), Coral Harbour (He,S).
B. pallescens Schleich. Cambridge Bay (H).
B. pendulum (Hornsch.) Schimp. Cambridge Bay (He,S).
B. pseudotriquetrum (Hedw.) Schwaegr. Resolute (H), Coral Harbour (He,M,S). Fort Chimo (K,S), Great Whale R. (M,W).
B. rutilans Brid. Frobisher Bay (H).
B. salinum Hag. Resolute (M), Coral Harbour (M), Frobisher Bay (S), Great Whale R. (H,He).
B. wrightii Sull. & Lesq. Coral Harbour (S).
Calliergon giganteum (Schimp.) Kindb. Cambridge Bay (S), Coral Harbour (S).
C. richardsonii (Mitt.) Kindb. Cambridge Bay (M,S).
C. sarmentosum (Wg.) Kindb. Frobisher Bay (H,S). Fort Chimo (S), Great Whale R. (He,M,S).
C. stramineum (Brid.) Kindb. Knob Lake (H,M).
C. trifarium (W. & M.) Kindb. Coral Harbour (He,K), Fort Chimo (H,S).

C. turgescens (T. Jens.) Kindb. Resolute (H). Cambridge Bay (H,He,S), Coral Harbour (K,M,S), Great Whale R. (H).
Campylium stellatum (Hedw.) Lange & C. Jens. Cambridge Bay (H,He, K,S), Coral Harbour (H,K,M,S), Frobisher Bay (H), Fort Chimo (H,He,M,S), Great Whale R. (H), Knob L. (K).
Catoscopium nigritum (Hedw.) Brid. Resolute (H,S), Coral Harbour (H).
Ceratodon purpureus (Hedw.) Brid. Cambridge Bay (H), Coral Harbour (M,S), Frobisher Bay (H,M), Great Whale R. (S).
Cinclidium arcticum (BSG) Schimp. Resolute (H,K,S), Cambridge Bay (He), Coral Harbour (H,K,M,S), Frobisher Bay (S).
C. latifolium Lindb. Resolute (H,S), Coral Harbour (S).
C. stygium Sw. Fort Chimo (S).
Cratoneuron filicinum (Hedw.) Roth. Cambridge Bay (K), Coral Harbour (S).
Desmatodon leucostomus (R. Br.) Berggr. Cambridge Bay (H).
Dicranum angustum Lindb. Coral Harbour (He,M), Fort Chimo (H).
D. bergeri Bland. Fort Chimo (H,S), Great Whale R. (S).
D. bonjeani DeNot. Fort Chimo (He).
D. elongatum Schleich. Cambridge Bay (W), Frobisher Bay (H,He,M,S, W), Fort Chimo (H,He), Great Whale R. (H).
Dicranum fuscescens Turn. Frobisher Bay (He,S), Fort Chimo (S), Great Whale R. (S,K,M), Knob L. (S).
D. majus Turn. Frobisher Bay (He,H).
D. spadiceum Zett. Frobisher Bay (H,M).
Distichium capillaceum (Hedw.) BSG. Cambridge Bay (H), Coral Harbour (K).
D. inclinatum (Hedw.) BSG. Cambridge Bay (H), Coral Harbour (H).
Ditrichum flexicaule (Schwaegr.) Hampe. Resolute (H,He,K,S), Cambridge Bay (H,He,K,S), Coral Harbour (H,He,K,W), Frobisher Bay (H,K), Fort Chimo (M,S), Great Whale R. (K,S).
Drepanocladus badius (Hn.) Roth. Coral Harbour (He,M), Frobisher Bay (He), Fort Chimo (M), Great Whale R. (S), Knob L. (He).
D. brevifolius (Lindb.) Warnst. Resolute (H,S), Cambridge Bay (H,He, K,S), Coral Harbour (K,M), Frobisher Bay (H).
D. intermedius (Lindb.) Warnst. Resolute (M), Cambridge Bay (He), Frobisher Bay (He).
D. purpurascens (Schimp.) Loeske. Great Whale R. (S).
D. revolvens (Sw.) Warnst. Resolute (M,S), Cambridge Bay (S), Coral Harbour (H,He,K,M,S), Frobisher Bay (H,He,K,S), Fort Chimo (H, M,S), Great Whale R. (H,K,M).
D. tundrae (Arn.) Loeske. Cambridge Bay (S).
D. uncinatus (Hedw.) Warnst. Resolute (He), Cambridge Bay (He,K), Coral Harbour (H,He,K,M), Frobisher Bay (H,K,M), Great Whale R. (H,He,K,M,S), Knob L. (H).
D. vernicosus (Lindb.) Warnst. Cambridge Bay (H), Coral Harbour (S).
Encalypta alpina Sm. Resolute (H,M,S), Cambridge Bay (H), Coral Harbour (H).
E. procera Bruch. Frobisher Bay (H).
Eurhynchium pulchellum (Hedw.) Jenn. Cambridge Bay (H,W).
Fissidens osmundioides Hedw. Frobisher Bay (H,M), Fort Chimo (H).
Funaria hygrometrica Hedw. Cambridge Bay (H).
Grimmia torquata Hornsch. Frobisher Bay (H).
Hylocomium splendens (Hedw.) BSG. Coral Harbour (H), Fort Chimo (H,S), Great Whale R. (K,M,S).

Hypnum bambergeri Schimp. Resolute (He,M,W), Cambridge Bay (S,H,), Coral Harbour (H,He,K), Frobisher Bay (He).
H. hamulosum Br. & Schimp. Frobisher Bay (H).
H. revolutum (Mitt.) Lindb. Resolute (K,S), Cambridge Bay (H,K,W), Coral Harbour (He,M), Frobisher Bay (He), Great Whale R. (H,S).
Isopterygium pulchellum (Hedw.) Jaeg. Cambridge Bay (H), Frobisher Bay (H,M).
Leptobryum pyriforme (Hedw.) Wils. Cambridge Bay (S), Coral Harbour (M).
Leskeella nervosa (Brid.) Loeske. Resolute (K).
Meesia triquetra (Hook. & Tayl.) Ängstr. Resolute (H,S), Coral Harbour (S).
Meesia uliginosa Hedw. Resolute (H), Cambridge Bay (S), Coral Harbour (S), Frobisher Bay (H), Great Whale R. (S).
Mnium andrewsianum Steere. Resolute (S), Coral Harbour (S).
M. medium BSG. Coral Harbour (S).
M. orthorhynchum BSG. Coral Harbour (K), Frobisher Bay (H,M).
M. pseudopunctatum Br. & Schimp. Fort Chimo (S).
M. rugicum Laur. Coral Harbour (S).
Myurella apiculata (Hüb.) Bruch. Coral Harbour (He), Frobisher Bay (H).
M. julacea (Schwaegr.) BSG. Resolute (H,He,W), Cambridge Bay (H), Coral Harbour (H,K,S).
Oncophorus wahlenbergii Brid. Cambridge Bay (K), Coral Harbour (He), Frobisher Bay (H,S), Great Whale R. (S).
Orthothecium chryseum (Schwaegr.) Br. & Schimp. Resolute (K,M,S), Cambridge Bay (He), Coral Harbour (H,He,K,S,W), Frobisher Bay (S).
O. intricatum (Hn.) Br. & Schimp. Resolute (M,S), Coral Harbour (M).
Orthotrichum killiasii C.M. Cambridge Bay (K,W).
Paludella squarrosa (Hedw.) Brid. Frobisher Bay (He), Fort Chimo (H).
Philonotis tomentella Mol. Frobisher Bay (S), Great Whale R. (M).
Pleurozium schreberi (Brid.) Mitt. Coral Harbour (M), Fort Chimo (H, He,S), Great Whale R. (H,He,M,S), Knob L. (K).
Pogonatum alpinum (Hedw.) Röhl. Coral Harbour (He), Great Whale R. (M.) Var. *septentrionale* (Röhl.) Brid. Coral Harbour (He).
Pohlia cruda (Hedw.) Lindb. Coral Harbour (H,He), Frobisher Bay (H,M).
P. crudoides (Sull. & Lesq.) Broth. Frobisher Bay (M).
P. nutans (Hedw.) Lindb. Coral Harbour (H), Frobisher Bay (M,S), Fort Chimo (He).
Polytrichum hyperboreum R. Br. Fort Chimo (He).
P. juniperinum Hedw. Knob L. (H).
P. piliferum Hedw. Frobisher Bay (H,K), Knob L. (H).
P. strictum Sm. Coral Harbour (He,M), Frobisher Bay (S), Great Whale R. (S).
Pottia obtusifolia (R. Br.) C. M. Cambridge Bay (H,S), Coral Harbour (M).
Pseudostereodon procerrimum (Mol.) Fl. Resolute (He), Cambridge Bay (He).
Rhacomitrium canescens (Hedw.) Brid. Frobisher Bay (M).
R. lanuginosum (Hedw.) Brid. Coral Harbour (H,M). Frobisher Bay (H,He,M,S,W), Fort Chimo (H,M), Great Whale R. (He,M,S).
R. sudeticum (Funck) Br. & Schimp. Frobisher Bay (H).

Rhytidium rugosum (Hedw.) Kindb. Coral Harbour (He), Frobisher Bay (M), Great Whale R. (K,M,S).
Schistidium apocarpum (Hedw) BSG. Cambridge Bay (H), Coral Harbour (H), Great Whale R. (H,S).
S. strictum (Turn.) Loeske. Great Whale R. (S).
Scorpidium scorpioides (Hedw.) Limpr. Cambridge Bay (S), Fort Chimo (H,K,S).
Splachnum vasculosum Hedw. Coral Harbour (S).
Tetraplodon mnioides Hedw. Frobisher Bay (S), Great Whale R. (S).
Timmia austriaca Hedw. Resolute (He), Cambridge Bay (He,W), Coral Harbour (He).
T. norvegica Zett. Resolute (S), Cambridge Bay (H), Coral Harbour (S).
Tomenthypnum nitens (Hedw.) Loeske. Cambridge Bay (H,He,K), Coral Harbour (H,He,S,W), Frobisher Bay (He,K), Fort Chimo (H,He,K, S), Knob L. (K,M).
Tortella fragilis (Hook. & Wils.) Limpr. Cambridge Bay (H), Coral Harbour (H,K), Frobisher Bay (K,M).
T. tortuosa (Hedw.) Limpr. Resolute (S).
Tortula ruralis (Hedw.) Crome. Resolute (K), Cambridge Bay (He,W), Coral Harbour (He), Frobisher Bay (H), Fort Chimo (H).

In all, 162 species (44 Hepaticae, 10 Sphagnales, and 108 Bryales) were found, distributed as follows:

Resolute	32 (Hepaticae	1, Sphagnales	0, Bryales 31)
Cambridge Bay	56 (Hepaticae	7, Sphagnales	0, Bryales 49)
Coral Harbour	79 (Hepaticae	12, Sphagnales	3, Bryales 64)
Frobisher Bay	69 (Hepaticae	18, Sphagnales	2, Bryales 49)
Fort Chimo	51 (Hepaticae	16, Sphagnales	7, Bryales 28)
Great Whale R.	47 (Hepaticae	15, Sphagnales	1, Bryales 31)
Knob L.	21 (Hepaticae	2, Sphagnales	2, Bryales 11)

Annotations

Cephaloziella divaricata (Fr.) Schiffn. This species was found by Dr. S. Arnell sparingly mingled with specimens of *Lophozia ventricosa* (+ *Sphenolobus minutus* and *Polytrichum strictum*) sent him for confirmation.

Leiocolea heterocolpos (Thed.) Buch. The specimens are so small and depauperate that it is not possible to decide whether they belong to typical *L. heterocolpos* or to the var. *harpanthoides* (Bryhn & Kaal.) Schust.

Lophozia groenlandica (Nees) Bryhn. At Great Whale R. (*Sørensen;* verified by S. Arnell), the species grew in tufts of *Dicranum bergeri* and was also associated with *Sphenolobus minutus*. Hultén's specimen from Baffin I. was picked from a sheet of *Salix herbacea;* other bryophytes were *Dicranum elongatum* and *Orthocaulis quadrilobus* var. *heterophylla*. This little known species has recently been studied by S. Arnell (Arnell & Mårtensson, 1959) and Schuster *et al.* 1960.

Lophozia ventricosa (Dicks.) Dum. Determination verified by S. Arnell.

Marchantia alpestris Nees, Syn. Hep. (1844), *emend.* Burgeff, Gen. Stud. March. 1943, p. 33. This taxon has, on the whole, been neglected and especially so in North America. In the recent index to volumes 1-60 of *The Bryologist* it is not mentioned. In his monograph on American species of *Marchantia,* Evans (1917, pp. 236-237) discussed under *M. polymorpha* the var. *aquatica* Nees and the var. *alpestris* Nees, and though he pointed out several characters, he concluded, "Although var. *aquatica* and var. *alpestris* are at first sight so distinct from each other they are connected by intermediate forms, and their differences seem to be associated with definite differences in environmental conditions. They represent, therefore, modifications rather than varieties in the taxonomic sense." He preferred to deal with them as fo. *alpestris* (Nees) K.M.

In Europe *M. alpestris* generally has been treated as a variety. S. Arnell (1956), following Burgeff, treated it as a species in his Scandinavian hepatic flora. K. Müller (1957) took it as a variety. We agree with Burgeff. As compared with *M. polymorpha* L., the thallus is thicker, more leathery and more pale; the branches are shorter and wider; the female peduncles are usually shorter and thicker and the perichaetia longer; gemmae are rarer than in *M. polymorpha.* In the field it is easily separated from *M. polymorpha,* because the black line along the middle of the thallus found in the latter is lacking in *M. alpestris.* The distribution of *M. alpestris* is given by S. Arnell as Scandinavia, mountain areas of central Europe, Madeira, and arctic regions of North America. (K. Müller, 1957, reported it only from Europe.) To these may be added the northern Siberian localities mentioned by H. W. Arnell (1917) as the var. *alpestris* Nees; in the same work he reported it from Port Clarence in the Bering Strait region. In the rich Alaskan collections studied by the senior author of the present paper were found, besides several stations for *M. polymorpha,* three localities for *M. alpestris* in the Central Pacific Coast district, all from alpine or subalpine situations. The species is rather common in Greenland along brooks or in other moist places in *Salix glauca* copses. Its known northern limit is in West Greenland at about 70°; in East Greenland it is found as far north as 73°. *M. polymorpha* seems to be rare in Greenland and is confined to burned patches and other very fertile places.

A study of the material of *M. polymorpha* s. lat. in the herbarium of the Riksmuseet in Stockholm gives evidence for supposing that *M. alpestris* has a much wider distribution, also, for example, in mountains of Mexico and in southernmost parts of South America.

Marsupella arctica (Bergg.) Bryhn & Kaal. (*M. groenlandica* C. Jens.) This very characteristic species, collected on Southampton I. by J. K. Morton, was previously known from Greenland, Spitsbergen, Ellesmere I., southern Baffin I., and two localities in northern Quebec (see Schuster, 1951). Persson has recently received material of this species from Alaska (Central Yukon district, Upper Salcha River, *A. W. Johnson,* 1949; Bering Strait, Ogotoruk Creek drainage, *A. W. Johnson, L. Viereck,* & *H. Melchior,* 1959, det W. A. Weber).

Plagiochila arctica Bryhn & Kaal. *in* Bryhn, 1906-07. This species was described from material from different localities in arctic Canada and Greenland, collected by H. G. Simmons during the Second "Fram" Expedition. Arnell (1913) reported it from Siberia. It was neglected until Persson (1946, 1952) found it to be rather common in arctic Alaska. Schuster (1959-60), in his monograph on *Plagiochila* in North America, gave a thorough study of it and its relationship to *P. asplenioides,* etc. He called it (p. 147) "a strictly arctic polyploid derivative of *P. asplenioides.*"

Scapania degenii Schiffn. This interesting circumpolar subalpine-alpine species was first reported from North America by S. Arnell (1950). Schuster (1958) published a map of the North American distribution; it includes 12 localities, all from the northeastern part of the continent. Among some hepatics collected by Steere in northernmost Alaska, the senior author found good specimens of *S. degenii* (to be reported soon). *S. degenii* has been much confused with *S. nemorosa* as well as with *S. irrigua,* and as a result its range is still poorly known. It was first found in the Alps and later in North America. It is now known from a dozen localities in Scandinavia and a few in Great Britain and Siberia. The closely related *S. hedbergii* S. Arn. is found in the alpine region of Mt. Kenya, eastern Africa (S. Arnell, 1956). The senior author cannot agree with Schuster (1951) that there should be any doubt about the taxonomic value of *S. degenii;* he especially considers its affinity to *S. hyperborea* much exaggerated. Having studied it, some 25 years ago, in different localities in the field as well as in herbaria, from all parts of its range, he is definitely convinced, as from the beginning, that *S. degenii* is a first-class species well characterized by a couple of characters. He would like to put special stress on the rather unique denticulation and the gemmae which strongly resemble those of *S. nemorosa.*

Scapania obcordata (Berggr.) S. Arn. *in* Arn. & Mårt., 1959, p. 117 (*Sarcoscyphus obcordatus* Berggr., 1875). Great Whale River, *Morton, teste* S. Arnell; specimen removed from a *Saxifraga,* growing with *Dicranum fuscescens, Ditrichum flexicaule,*

and *Lophozia latifolia*. The species was previously known only from Spitsbergen, where it was collected by Berggren, 1868. According to Arnell & Mårtensson (1959), it seems to be rather abundant in certain parts of these islands, growing "on moist excaved soil, on road- and tracksides. Generally it was found as brownish to blackish (exceptionally, pale green to green) dense carpets or coverings which sometimes contain *Anthelia juratzkana, Cephalozia ambigua, Cephaloziella arctica*, structures of various mosses, etc." Arnell pointed out that the species, which is known elsewhere only from a dozen localities in the Scandinavian mountain ridge, agrees with *S. lapponica* as to the shape of the leaves and thus belongs to the subgenus JENSENIA S. Arn. It differs from *S. lapponica* in its smaller cells and papillose cuticle.

Schuster (1959) published on the hepatics of northern Ellesmere Island and reported *S. lapponica* (Arn. & Jens.) St. from two localities there. Samples were sent to S. Arnell, who believed the material probably not identical with *S. lapponica;* he compared it with *S. obcordata* but was not quite sure of the identification.

The Spitsbergen material and *S. lapponica* from different localities in Scandinavia were studied in order to determine whether, as Persson supposed, *S. lapponica* and *S. obcordata* are identical. It is true that the cell structure in *S. lapponica* is much more delicate than in *S. obcordata*, and the papillose cuticle of the latter species was never found in *S. lapponica*, but characters of real importance for separating the species were not found. Until the perianth and fruit of *S. lapponica* are found, this problem can hardly be solved.

Scapania obscura (Arn. & Jens.) Schiffn. Baffin I., Frobisher Bay, on soil, sparingly mixed with sterile *Pohlia nutans*, determination verified by S. Arnell. New to North America, previously known only from Europe (Scandinavia in the mountain range, in some areas rather common; Switzerland). The species was first mentioned in the literature by H. W. Arnell (1892), who in a paper dealing with hepatics from northern Norway placed it under *S. subalpina* (Nees) Dum. as "forma atra, gracilis et lobis distantibus." In their work on the bryophytes of the Sarek region of Swedish Lapland, Arnell and Jensen (1907) described this taxon as *Martinellia obscura* and reported it from two localities in Sweden and one in Norway. They made the remark that the leaves sometimes could be nearly flat and then not unlike *Gymnocolea inflata*. They placed the new species near *S. subalpina*, and so did K. Müller (1911-16). Buch (1928) in his outstanding *Scapania* monograph placed *S. obscura* and *S. uliginosa* (Sw.) Dum. in his new

section OBSCURAE, and in this he was followed by S. Arnell (1956). K. Müller (1957) placed *S. obscura* immediately after *S. uliginosa* in M Gruppe UNDULATAE, and remarked: "Die Pflanze ist charakterisiert durch Kleinheit, schwarze Farbe und ihr Vorkommen in der alpinen Region. Sie ist eine gute Art mit einiger Verwandtschaft mit *S. subalpina* und *S. uliginosa*."

Scapania obscura is up to 2 cm. high and 2 mm. wide. The color is dark brown to nearly black. The leaf lobes are as in *S. subalpina*, both nearly the same size. The cell structure resembles that of *S. uliginosa*, but in the latter the ventral leaf lobe is decurrent; this is not the case in *S. obscura* (or in *S. subalpina*). The perianth is unknown. The gemmae are ovate, 1-2-celled, 8-14 × 15-20 μ (K. Müller, *l. c.*); they are rare.

S. Arnell (1956) characterized the occurrence of the species in Scandinavia as "in streams and springs and bogs in the alpine and higher parts of the subalpine region." It has no doubt often been overlooked because of its small size and its resemblance to *Gymnocolea*.

Tritomaria heterophylla Schust. Southampton I., Coral Harbour, *Sørensen*, growing on soil with *Bryoerythrophyllum recurvirostrum*, *Campylium stellatum*, *Distichium* sp., *Leiocolea badensis*, and *Preissia quadrata*. The specimen was first taken for a deviant of *T. scitula* but on consulting Schuster's (1958a) paper the senior author became aware that it matched completely *T. heterophylla*, which is a fine species. Until now it has been known from only four localities in northeastern Ellesmere, where it was collected by Schuster. Our specimen is quite typical and has well-developed gemmae. From Schuster's thorough study of this species (p. 275) the following may be cited: "A strongly isolated species, recognizable in the field (with hand-lens) on the basis of the somewhat crispate, trilobed, broad leaves, the often somewhat pellucid appearance of the leaves (more than in *Tritomaria quinquedentata*, which is a relatively opaque plant), and by the vineous pigmentation of the leaf-bases" and (p. 278) "In spite of the marked differences in leaf shape, in pigmentation, and in the size of the gemmae, *T. heterophylla* is perhaps best regarded as a high-arctic derivative of *T. scitula*."

Sphagnum lenense H. Lindb. (*S. lindbergii* var. *microphyllum* Warnst.) Baffin I., Frobisher Bay, among other species of *Sphagnum*, *Hedberg*. It is difficult to understand why this species has not been accepted by all bryologists. In our opinion it is a very clear-cut species with an interesting distribution. Persson (1949) made an account of the species in Alaska and compared it with *S. lindbergii*. In North America it has also been reported from a small

area on the west coast of Greenland between 68° and 70° N. latitude (Lange, 1952). The present find in Baffin I. indicates that it will prove to have a continuous area across the continent following low-arctic and subarctic zones. In Eurasia it seems to be distributed from eastern Finland eastward to Bering Strait. A number of vascular plants and mosses are known to have a similar distribution.

Sphagnum subfulvum H. Sjörs. In his paper on this species Sjörs (1944) did not enumerate any specimens from America other than some from the middle part of West Greenland. Our record from Ungava Bay seems to represent the first report of this species from Canada.

Sphagnum tenellum Pers. This can hardly be called a truly arctic or subarctic species. Apparently an oceanic species, in North America it has been reported from the northern part of the Pacific coast and also from northeastern United States, Quebec, and Labrador on the Atlantic coast. In Europe it may also be regarded as oceanic, becoming rare in eastern Europe.

Aulacomnium acuminatum (Lindb. & Arn.) Par. Southampton I., Coral Harbour, growing with *Brachythecium turgidum, Bryum pseudotriquetrum, Dicranum elongatum, Ditrichum flexicaule, Orthothecium chryseum,* and *Tomenthypnum nitens.* This pronounced arctic species has a very wide distribution (see maps in Persson, 1949, and Steere, 1953) in northernmost Siberia and in North America from Alaska to northwestern Greenland (see also Holmen, 1957, and Crum, 1958).

Amblystegium varium (Hedw.) Lindb. The arctic occurrence of this species must no doubt be accepted. It has recently been reported from several localities in northernmost Greenland (Holmen, 1960). In some respects it resembles depauperate forms of *Cratoneuron,* but the lack of paraphyllia, the cells of the leaf base, and the slight sinus of the upper part of the nerve will place it best in *A. varium.* It seems to be a species of calcareous soils both in Greenland and in the Canadian Arctic.

Brachythecium groenlandicum (C. Jens.) n. comb. *Hypnum albicans* Neck. var. *groenlandicum* C. Jens. Medd. Grønl. 15: 437. 1897. *Brachythecium albicans* var. *groenlandicum* (C. Jens.) Broth., Die Laubmoose Fennoskandias. 510. 1923. The SALEBROSIA-group is one of the most difficult groups in the genus *Brachythecium.* Several species have in the course of time been reported from the arctic, such as *B. albicans, B. glareosum, B. mildeanum, B. salebrosum, and B. turgidum.* But a recent revision (made by junior author) of all Greenland material of *Brachythecium* has proved that almost all specimens of the SALEBROSIA-

group could be referred easily to one or the other of two very clear taxa, *B. turgidum* or *B. groenlandicum*. The rest of the Greenland material of this group represents chiefly subarctic specimens, which probably can be referred to the true *B. salebrosum*.

B. groenlandicum was described by Jensen (*l.c.*) as a variety of *B. albicans* from a specimen collected by N. Hartz in northeastern Greenland on the Hold with Hope peninsula in 1891 (type). In the same paper he listed a number of specimens from the Scoresby Sund area. *B. groenlandicum* is close to both *B. salebrosum* and *B. albicans* but is nevertheless quite characteristic. The plants are julaceous and irregularly pinnate, and the stem tip is almost always hooked; the leaves are densely imbricate, plicate (giving the whole plant a silky lustre, not unlike small specimens of *Rhytidium rugosum*), and usually more or less secund. See further the description by Jensen (*l.c.*) and the illustrations in Arnell & Jensen (1907, p. 208, fig. 17).

B. groenlandicum grows in moist habitats, either on rock surfaces where it can form extensive mats, or in moist heaths on soil and very often mixed with other species of mosses. The species has a wide distribution in Greenland (Holmen, 1960), where it seems most frequent in areas with basalts and sediments. It has also been reported from northern Scandinavia and from the Bering Straits region of Alaska (Persson, 1954). It is probably widely distributed in the arctic.

Brachythecium turgidum (Hn.) Kindb. This species seems to be accepted now by all bryologists. It is is usually large and unbranched and grows in wet habitats. In Greenland it is most common in calcareous areas. Like the preceding this species seems to be circumpolar-arctic.

Bryum crispulum Hampe. This taxon is recognized as a species only after much hesitation. Quite possibly it represents a xerophilous modification of *B. pseudotriquetrum*. It has never been found in fruit.

Bryum ovatum Jur. This arctic-alpine species was reported from Alaska as new to North America by Persson (1952, pp. 99-100; see also the discussion of *B. neodamense*, pp. 97-98). It is the arctic-alpine parallel to *B. neodamense*, which, however, inhabits the lowlands. Both grow on markedly calcareous substrata.

Bryum salinum Hag. Andrews (1935-40) treated this species as a synonym of *B. archangelicum* Br. & Schimp. As pointed out by Persson (1952) and later confirmed by Nyholm and Crundwell (1958), this is incorrect. *B. archangelicum* is a mountain species distinguished by several good characters from *B. salinum*, which is a species of salt marshes. As synonyms of *B. archangeli-*

cum Andrews placed no fewer than 14 species, of which probably all, or at least most of them, contrary to *B. archangelicum*, belong to the section HAEMATOSTOMA Hag. The majority of these species were collected by the "Fram" Expedition (Bryhn, 1906-07) in arctic North America. Among them are *B. salinum* and also *B. lapponicum* Kaur. Nyholm and Crundwell (1958) pointed out that *B. salinum* has generally been called *B. lapponicum*, but the first name has priority. *B. salinum* from Alaska was reported by Persson (1952) under the name of *B. lapponicum* coll. Nyholm & Crundwell (1958) reported the species from one locality in Alaska and one in Manitoba and also from Great Britain, the Baltic coast of Germany, and Spitsbergen. It was previously recorded from the coasts of Sweden, Norway, Finland, and Denmark. Nyholm in her interesting and valuable treatment (1958) said of *B. salinum*. "I think that this is a common halophytic species, but it has not always been recognized. Because it is common and very variable, but only little known, it has been described with numerous names."

Bryum wrightii Sull. & Lesq. Southampton I., *Sørensen*. This beautiful and easily recognized *Bryum* seems to be restricted to the arctic. It has been reported from a number of localities in arctic North America, Asia, and Europe, but it is rare. In Greenland it has been found only in a small area in West Greenland and a small area in East Greenland, both situated between 70° and 73° N.

Dicranum angustum Lindb. (*D. laevidens* Williams). This circumpolar subalpine-alpine species is still too little known. Most bryologists who have studied it have accepted it as a species of its own (for example, Brotherus, Hagen, Mårtensson, and also Tuomikoski, who has studied this and related species thoroughly). The senior author (1952a) dealt with its American range as well as its general distribution and placed *D. laevidens* Williams as a synonym of it. (Grout in his *Moss Flora* had suggested that it might be regarded as a variety of the latter.)

Drepanocladus intermedius (Lindb.) Warnst. Sjörs has made an interesting study of this species and its close relative *D. revolvens* (Persson & Sjörs, 1960). We cite here only, "A calcicline (not strictly calcicolous), whereas the closely related, but in our opinion separable, *D. revolvens* s. str., is perhaps somewhat calcifuge."

D. purpurascens (Schimp.) Loeske. This alpine species is very common in the Scandinavian mountains. It seems to have a more or less circumpolar distribution (Persson & Sjörs, 1960).

D. tundrae (Arn.) Loeske. This characteristic calciphilous species which has a circumpolar distribution has been carefully studied by Tuomikoski (1949) in his monograph on the *Drepanocladus*

exannulatus group. (See also Persson, 1952a, and Persson & Weber, 1958.)

Drepanocladus vernicosus fo. *major* (Lindb.) Mönk., Die Laubmoose Europas. 772. 1927; *Amblystegium vernicosum* var. *majus* Lindb., Musc. Scand. 33. 1879; *D. vernicosus* var. *major* (Lindb.) Warnst., Laubm. 1020. 1906; *D. lapponicus* fo. *major* (Lindb.) Z. Smirn., Acad. Nauk SSSR Trudy Bot. Inst. 2, 8: 412. 1953. We have not been able to find any statement of the North American occurrence of this interesting moss except for a note by Grout in his *Moss Flora*. Under *D. vernicosus* he noted, without mentioning the distribution: "Very robust dark colored forms (often with a reddish tinge), with leaves less falcate, 3-4 mm. long are known as var. *major* (Lindb.) Warnst. = var. *turgidus* (Jur.) Moenkem."

Several robust forms are described in *D. vernicosus*. As to habit they often resemble *D. lycopodioides* or *D. revolvens*. They grow usually in wetter places and are not rarely submerged or floating. Forma *gigas* (Lindb.) C. Jens., fo. *lapponicus* (Lindb.) C. Jens., and fo. *major* subfo. *turgida* (Jur.) Mönk. are all more or less dark and often more or less purple. Forma *major* is green and is moreover less branched and has leaves that are generally less falcate, less plicate, and usually shorter than typical of *D. vernicosus*.

On the taxonomic value of *D. lapponicus* (Norrl.) Z. Smirn. the following notes should be proposed: The name is based on *Hypnum lycopodioides* var. *lapponicum* Norrl., Notis. Sällsk. F. Fl. Fenn. 13: 293. 1873. *Amblystegium vernicosum* var. *lapponicum* (Norrl.) Lindb., Musc. Scand. 33. 1879. Fo. *major* and fo. *gigas* were considered forms of *lapponicus*. Smirnova (1953) also recognized fo. *major* subfo. *inundatus* (Mönk.) Z. Smirn. and described the following new forms: fo. *gracilescens*, fo. *inundatus*, and fo. *violascens*.

Smirnova gave a map showing the distribution of *D. lapponicus* in middle and northern Sweden, Finland, the Baltic region, northern Russia, and northern Siberia. As *D. vernicosus* has a wide distribution in Europe and also in North America, the map suggests that we have to deal with a taxon of its own. But on studying the literature we find that in large parts of central and western Europe (for example, Great Britain and France) there is another form of *D. vernicosus* which must be discussed in this connection, namely, the fo. *major* subfo. *turgida* (Jur.) Mönk. [*Hypnum vernicosum* var. β *turgidum* Jur. ex Limpr., Kryptfl. Schles. 1: 69. 1876.] Limpricht (1904) gave as synonyms *Hypnum aduncum* β *giganteum* (haud Schimp.) H. Klinggr., 1864; *H. aduncum* var. *inundatum* Schimp.; *Amblystegium vernicosum* β *majus* Lindb.;

Hypnum fluitans δ *turgidum* Holler, and H. *lycopodioides* α *genuinum* *** *majus* †† *Holleri* Sanio, 1885. Limpricht also remarked that var. *lapponicum* (Norrl.) Lindb. and var. δ *gigas* Lindb. are to be united with *turgidum*.

According to Smirnova, *D. lapponicus* is characterized by a greater size, less branching, dark color, and also some characters concerning the sporophyte. Regarding size, her fo. *gracilescens* is described as "forma *tenuissima*." As for color her fo. *major* subfo. *inundatus* is characterized as "*viridi-luteus*" (fo. *major* in other works described as green). As regards the branching subfo. *inundatus* is said to be "sat ramosus." The sporophytic characters refer to differences in the cilia and the arrangement of the exothecial cells around the stomata; also the perichetial leaves are (in contrast to those of *D. vernicosus*) ecostate. At least the first two characters must be said to be subtle (too many segregate species in *Orthotrichum* and *Bryum*, for example, are founded on such characters) and still more when we consider that Smirnova has written the senior author that she had to wait two years to find a specimen with sporophytes of *D. lapponicus* (the taxa placed under *lapponicus* had only been found sterile before).

From what is stated above it may be clear that the specific value of *D. lapponicus* is very uncertain. In *Drepanocladus* we have analogous taxa regarded by all who have studied them as modifications or "varieties." The senior author refers to *D. intermedius* var. *cossoni* (Schimp.) Warnst. Jensen (1939) cited it as *D. revolvens* ssp. *intermedius* fo. *cossoni* (Schimp.) Warnst. and an analogous form in the related *D. revolvens* fo. *robustus* (Jensen, *l.c.*). We meet also here with more or less submerged forms, more robust than normal, less branched and dark colored, and practically always (as is the rule with all submerged bryophytes) sterile. Just as in the robust forms of *D. vernicosus* treated above, these forms occur occasionally within the area of their respective species. Considering this we conclude that *D. lapponicus* is to be looked upon merely as a modification of *D. vernicosus*.

Mnium andrewsianum Steere. This arctic species was also represented in our material: Cornwallis I. and Southampton I., *Sørensen*. Both records are probably new. Steere (1958) gave the distribution in North America, but added that it undoubtedly has a much wider distribution, as he had seen material from Siberia also. We have seen specimens from several localities in both West and East Greenland, and a specimen from Spitsbergen was found in the herbarium of the Riksmuseet, Stockholm; it was collected by S. Berggren in 1868 but was referred to *Cinclidium arcticum* by him (1875). It probably represents the first collection of this spe-

cies and may also be the northernmost one. It has not yet been found in northern Europe. In its distribution it resembles such mosses as *Bryobrittonia, Cinclidium latifolium,* and *Trichostomum cuspidatissimum.*

Mnium medium BSG (see next species).

Mnium rugicum Laur. The representatives of the *M. affine*-group still seem to be troublesome in the arctic. Tuomikoski (1936) pointed out that the true *M. affine* is a southern species; nevertheless several recent authors have reported it as occurring in the arctic. Our experience bears out Tuomikoski's opinion; two species seem to be important in the arctic, *M. rugicum* and *M. medium.* It is, however, still an open question if *M. seligeri* occurs in the true arctic. *M. rugicum* and *M. medium* are easily recognized by leaf areolation: The cells in *M. rugicum* are thin-walled, polygonal, and uniform in size; in *M. medium* they are thick-walled, rounded, and varying in size (with large and small cells intermingled (*cf.* figures in Möller, 1926). Furthermore, *M. medium* is synoicous, *M. rugicum* dioicous.

M. medium has a wide distribution in Greenland, ranging as far north as about 83° (Holmen, 1960), but *M. rugicum* is confined to the subarctic and the low-arctic part of the island, and so far has not been found north of 70°. *M. rugicum* is a species of wet situations, whereas the habitats of *M. medium* are moist grass-meadows and heaths.

Pseudostereodon procerrimum (Mol.) Fl. This beautiful, arctic-alpine, calcicolous species seems to be rather common in the Alps but is only rarely collected in other parts of its range: Scandinavia (two localities, both in Norway), the Caucasus, Siberia (Lena R., H. W. Arnell, 1913), China, and arctic North America (North Devon and King Oscar Land, Bryhn, 1906-07), and Alaska (Persson & Gjaerevoll, 1957).

Tomenthypnum nitens (Hedw.) Loeske. Most if not all of the material from the arctic islands (as the material sometimes consists of fragments, it is sometimes difficult to decide) belongs to var. *involutum* Limpr. [var. *atrichum* (Kindb.) Jens.]. It seems that in high alpine and arctic regions *Tomenthypnum* is represented only by this variety. The senior author met with this problem when studying material from an interglacial deposit in northernmost Sweden (Persson, 1960). With almost complete certainty he could state that the only bryophyte in the deposit belonged to var. *involutum,* which also was the only representative of *Tomenthypnum* in the mammoth deposit in the Taimyr peninsula (Savich-Ljubitskaja & Abramova, 1954). H. W. Arnell (1917) found that the *Tomenthypnum* collected by the "Vega" expedition along the

northern coast of Siberia was represented exclusively by the var. *involutum*.

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STUDIES ON HEPATICAE. III-VI.

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In the first paper in this series, on the genus *Temnoma* (1959), the problem of generic delimitation within the Blepharostomaceae was examined. In the second paper (1961), the new family Chaetophyllopsidaceae, with the new genera *Herzogianthus and Chaetophyllopsis*, was proposed to include certain elements previously incorrectly placed in *Blepharostoma*, in the Blepharostomaceae. In the present paper my studies of generic types are continued. The genesis of these studies as outlined in the first paper remains the same: an attempt to redefine, define and refine, as the case may necessitate, our existing generic concepts in the Hepaticae. It is intended, eventually, when the more troublesome questions to which my attention is currently directed are resolved, to prepare a conspectus of the genera of Hepaticae. For such a work there is an obvious need, as the only extant one with any claim to modernity is that of Schiffner (1893-95) in Engler and Prantl.

III. PLEUROZIA Dum. and EOPLEUROZIA gen. nov.

Jack (1886), in a monograph on *Physiotium*, as *Pleurozia* was then frequently named, assigned ten species to the genus; several additional ones have been subsequently added, *i.a.*, by Mitten and by Herzog (1950). Of the ten species Jack monographed, nine were provided with bifid leaves, with a ventral lobe that Schiffner (1893) aptly referred to as a "kahnförmigen oder sackartigen Unterlappen." The tenth species, *P. paradoxum* Jack, has unlobed leaves, without a ventral lobe, but with the leaves broadly involute. Stephani (1910), in his treatment of the genus, retained exactly the ten species as Jack treated them, and commented on the fact that the treatment by Jack was "ausführlich." Schiffner (*loc. cit.*, p. 115) referred to the same complex to which Jack assigned *P. paradoxum*, which he placed in a subgenus EXAURICULATA, a second species, *Pleurozia roraimae* (Mitt.) Schiffn. (*Blepharozia*

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roraimae Mitt.). This species is not alluded to under *Pleurozia* or *Blepharozia* by Stephani and has been quite lost sight of in the literature. A third species belonging to the EXAURICULATAE was described as *Pleurozia simplicissima* by Herzog (1950, p. 316.).

By contrast, the subgenus AURICULATAE, to which nine species were assigned by Jack and by Stephani, has been considerably more enriched by new species. This subgenus includes the generitype *Pleurozia purpurea* (Lightf.) S.O. Lindb. (*Pleurozia cochleariformis* Dum.) The members of this subgenus are provided with extremely complex, bifid leaves, which have been the subject of considerable investigation unnecessary to discuss in this connection. I wish only to emphasize my conviction that these species are not congeneric with the three species with simple leaves, which I believe must be relegated to a separate genus, as follows:

Eopleurozia gen. nov. Dioica. Planta habitu schistochiloideo, robusta, brunnea vel purpurea, 8-12 cm. alta, cum foliis 3-5 mm. lata. Caulis e caudice repente, e basi stoloniferus, ramis validis e basi brevissime adscendente-erectis, simplicibus vel bifurcatis, articulatis. Folia ramorum conferta, disticha, oblique patula, imbricata, concavissima, e basi latissima, maxime convoluta, marginibus inflexis vel involventibus, ovata, integerrima, apice ipso brevissime et inequaliter emarginato-bifidulo vel tridenticulato, basi breviter cordata; folia simplicia vel cum lobulis convoluta, ceterum sacculo ominino nullo nec foliis utriculariformibus praedita. Perianthium ca. 8 mm. longum, profunde multiplicatum et multifissum, laciniis angustissimis dense ciliolato-fimbriatis. Androecia minuta, spicata, pennatim disposita, bracteolis ca. 10-12 jugis; monandra.

TYPUS: *Physiotium paradoxum* Jack, Hedwigia 25: 85. pl. 10. 1886. *Pleurozia paradoxa* (Jack) St., Sp. Hep. 4: 236. 1910. **Eopleurozia paradoxa** (Jack) comb. nov.

Dioecious. Plants vigorous, often with the facies of *Schistochila*, 8-12 cm. tall and (2)3-5 mm. wide, brownish to purplish, densely caespitose. Stems from a stoloniferous base, simple to bifurcate, weakly complanate, ca. 14-15 cells high, with a weakly defined cortical layer (1)2 cells thick. Leaves simply organized, elobulate or with rudimentary lobule, distichous, obliquely to widely patent, closely imbricate, ca. 3 mm. long × 2 mm. wide, concave and wide at the base, strongly convolute, ovate-pointed, dilated-auriculate basally to shortly cordate, entire-margined but apex shallowly and unequally bilobed or emarginate, or tridentate; when discernible, lobulus rudimentary, without any saccate development whatsoever. Apical cells nearly hexagonal, ca. 30-32 μ in diameter, the basal gradually larger and becoming 25-30 × 50 μ; trigones very coarse, nodulose, separated by thin intervening walls. Perichaetial bracts

nearly similar to leaves, convolute, at apex erose-fimbriate. Perianth ca. 8 mm. long, narrowly pyriform, narrowed to mouth, deeply multiplicate and at mouth multifid, the laciniae slender, densely ciliate-fimbriate, the cilia articulate, flexuous. Androecia slenderly spicate, pinnately oriented, their length not or hardly equalling the stem leaves; bracts ca. 10-12 pairs, to 1 mm. long, oblong-elliptical, concave, the margins both strongly inflexed or involute; apex shallowly and unequally bilobed; monandrous; archegonia 5-7.

The above diagnosis is partly derived from **Eopleurozia simplicissima** (Herz.) comb. nov. [*Pleurozia simplicissima* Herz., Trans. Brit. Bryol. Soc. 1(4): 316. Fig. 32. 1950], a species known only from Borneo, and partly from the generic type.

Jack pointed out that his *Physiotium paradoxum* has the characteristic tubular organs ("tubi vacui" = modified perianths?), as well as the characteristic, compactly spicate androecia of other species of *Pleurozia* (*Physiotium*). However, it diverges from all other species in the "anders gestaltete Gliederung der Äste," as well as in the form and margins of the leaves. The leaf margins bear a hyaline border; such a border is lacking in *E. simplicissima*. The branching patterns in *Eopleurozia paradoxa* are unique: the branch originates as a bud within the axil of an enlarged stem leaf and bears at its base 2-3 small, spicate androecia. The tubular organs ("Röhrenorgane") are lacking in *E. simplicissima*, according to Herzog.

The type species of the genus has been collected only in Colombia and, according to Stephani (*loc. cit.*) in British Guiana in the vicinity of Mt. Roraima.[2] In another conjunction this plant will be described and fully illustrated.

IV. Nowellia Mitt. and Delavayella St.

The genus *Nowellia* of Mitten (*in* Goodman's Nat. Hist. Azores. 321. 1870) is based on *Cephalozia curvifolia*. The genus is a close ally of *Cephalozia*, the type genus of the Cephaloziaceae. Quite characteristic of this family are, *i.a.*, the anisophylly of the vegetative shoots, with small underleaves, or the underleaves reduced to slime papillae, linked with isophylly in the gynoecia, with bracts and bracteole essentially identical in form and size. I do not know of any genus currently attributed to the Cephaloziaceae where this marked contrast in *degree* of development of the appendages of the

[2] The allusion to the occurrence on Mt. Roraima suggests that Stephani considered *Blepharozia roraimae* Mitt. [*Pleurozia roraimae* (Mitt.) Schiffn.] as identical with *P. paradoxa* (Jack) Schiffn. (*Eopleurozia paradoxa* [Jack] Schust.). However, the former species is not cited in synonymy under the latter in Stephani (1910).

three rows of merophytes fails to obtain; it is also diagnostic of *Odontoschisma* and its allies, which Müller (1951-58) considered to represent a discrete but closely allied family, the Odontoschismaceae, but which Schuster (1949) placed as a subfamily of the Cephaloziaceae. Linked with this criterion are several others which are frequently stressed as of familial significance in separating the Cephaloziaceae, among them: (1) the cells are non-collenchymatous, developing under exposed conditions and conditions of difficult water uptake equally thick walls; (2) the antheridia occur singly in the small-sized perigonal bracts; (3) the perianths are sharply trigonous.

It would hardly seem necessary to re-emphasize the cardinal distinctions of the Cephaloziaceae, but the Indian botanists have in recent years apparently been unable to differentiate between members of this family and the genus *Delavayella* St. This last genus has been recently placed rather consistently in the Scapaniaceae, as by Evans (1939). However, Buch (1956) has recently suggested that this family, from which he had earlier segregated a family Schistochilaceae, was still polyphyletic, and segregated from it the family Balantiopsidaceae. It is my opinion that *Delavayella* St. and possibly *Blepharidophyllum* Ängstr., which Buch retained in the Scapaniaceae, bear also no immediate affinity to the Scapaniaceae *s. str.*, and should be segregated as the Delavayellaceae fam. nov. (see no. V, below). Wherever *Delavayella* is placed, it bears no affinities to the Cephaloziaceae, and it is delineated by an ensemble of characters that make the vegetative plant readily recognizable: the transversely oriented leaves, bilobed at the apex, with the postical margin inflexed to form a water-sac; the vigorous size; the strongly collenchymatous cells; the total lack of appendages from the ventral merophytes, even in the gynoecium.

Chen (1955) stated that "die ausgezeichnete monotypische Gattung *Delavayella* ist bisher endemisch in China" and points out that the single species, *D. serrata* St., is very poorly known, being previously known only from Yunnan. He reported an additional locality from "Omei-schan, Chi-li-pou, Prov. Szetschwan," assigning the material to a var. *purpurea*. Chen, however, overlooked the fact that the species also occurs in India, having been described from Girgaon (6000 ft.) about 67 mi. northeast of Almora, in the western Himalayas, by Pandé and Srivastava (1942). For this oversight Chen can hardly be blamed, since Pandé and Srivastava described the plant as *Nowellia indica* n.sp.! If the rather good figures of these last authors are compared with those of Chen (*loc. cit.*, fig. 10), the total identity of the material will be readily evident even to the most casual observer.

Pandé and Srivastava made the interesting observation that Chopra (1938) had described from sterile material a "*Nowellia orientalis* Chopra," which Pandé and Srivastava admitted shows "a striking similarity in the vegetative characters." They hazarded a guess that it "may be that the two plants are identical; but one can never be definite on the resemblance of the vegetative features alone." I can only assume that it never occurred to the authors to send part of their material to Chopra, or, inversely, to ask for loan of Chopra's type, but that it would be better to keep on bravely describing new synonyms in wrong genera in wrong families! The current ill-repute in which taxonomy is held in so many quarters, particularly the taxonomy of lower groups, surely does not need to be given such gross instances to reinforce a subjective opinion for which there is already so much basis!

From the preceding it seems adequately clear that the genus *Delavayella* still remains monotypic, with such a unique and striking habitus that no reason can exist for confusing it with *Nowellia*. When Pandé and Srivastava placed their plant in *Nowellia* they did so "because of the characteristic inflexed and saccate postical margin of the leaf." Yet they pointed out that their plant differs from "all previously described species of *Nowellia*" in that the gynoecium lacks a bracteole; the leaves are not drawn out into capillary segments; the male bracts are 1-4-androus. The lack of a bracteole in the gynoecium is alone sufficient to exclude the plant from *Nowellia*, and, indeed, from the Cephaloziaceae.

The following pertinent synonymy seems clearly indicated: *Delavayella serrata* St., Hedwigia 33: 4. 1894; Sp. Hep. 4: 119. 1910. *Nowellia orientalis* Chopra, Proc. Indian Acad. Sci. 8: 43. 1938, new syn. (provisional). *Nowellia indica* Pandé & Sriv., *Ibid.* 16: 178. Fig. 1-16. 1942, new syn. Whether Chen's var. *purpurea* is other than a mod. *colorata* is not clear.

V. The family DELAVAYELLACEAE fam. nov.

With progressively more acute analysis of the existing taxa of Hepaticae, it has become quite clear that in the past there has been a considerable tendency towards the aggregation of genera into portmanteau families that are actually polyphyletic. The family Scapaniaceae is an example of how progressive and repeated study gradually narrowed our concepts of it to the point where a more nearly homogeneous taxon resulted. For example, Buch (1928) split off the Schistochilaceae and (1956) the Balantiopsidaceae, leaving in the Scapaniaceae six genera, *Diplophyllum* Dum., *Douinia* Buch, *Scapania* Dum., *Scapaniella* Buch, and two very locally distributed genera, *Blepharidophyllum* Angstr. and *Delavayella* St.

Scapaniella has not been accepted by a number of recent workers, including Schuster (1953) and Müller (1951-58), leaving five unchallenged genera.

It is my opinion that the two genera *Delavayella* St. and *Blepharidophyllum* Ångstr. do not bear immediate affinities to the Scapaniaceae, although it is possible that the latter can be retained in the Scapaniaceae—even though it is quite impossible to follow Schiffner (1893-95), who stated that the genus "verbindet *Diplophyllum* mit *Scapania*." For the time being I retain *Blepharidophyllum* in the Scapaniaceae, although with some misgivings, whereas *Delavayella* must certainly be segregated into a unigeneric family as follows:

Delavayellaceae fam. nov. Plantae majusculae, laxe caespitosae, foliosae, tenerae et flaccidissimae. Caulis parum ramosus, ad 5 cm. longus, apice abrupte defoliatus, in flagellum subnudum attenuatus, propaguliferus, propagula in squamulis minutis appressa, hyalina, globosa, unicellularia, ramis lateralibus ex axilla interna foliorum ortis, basi tantum radicans longeque procumbens. Folia disticha, basi conduplicate concava, arcuate patula, superne explicata et deplanata; antica longe decurrentia, apice quam basi triplo angustiora, ad 0.3 biloba, sinu anguste obtuso, lobis acutis, serratis, inaequalibus, antico majore; margino antico anguste recurvo, postico basique sacculifero, sacculo alte cucullato, late basi inserto et e folii margine pendulo. Amphigastria caulina nulla. Cellulae mediae 27 × 36 μ, trigonis parvis saepe confluentibus. Dioica. Flores feminei in caule terminales, e facie postica innovati. Folia floralia plurijuga, conduplicata, arcte vaginantia, apice grosse biloba, sacculo nullo, amphigastria floralia nulla. Perianthia magna, anguste oblonga, compresso-cylindrica eplicata, ore vix angustato, late aperto quadrifisso, lobis triangulatis acutis, serrato-dentatis. Androecia ramuli terminalis, bracteis 1-4-andris.

Typus: *Delavayella* St. (1894). Good illustrations of *Delavayella* have been published by Chen (1955, fig. 10) and by Pandé and Srivastava (1942, sub *Nowellia indica*). The genus is known only from the type species, *D. serrata* St., Hedwigia 33: 4. 1894. The distribution, which involves northern India and Yunnan and Szechwan Provinces in southern China, appears to be highly restricted.

The Delavayellaceae agree with the Scapaniaceae in the axillary, intercalary branching; the terminal position of the gynoecium; the eplicate and compressed perianth; the bilobed leaves that develop marginal dentition; the collenchymatous leaf cells; the lack of underleaves and of a bracteole of the gynoecium; the ability to reproduce by gemmae. These similarities are impressive and sug-

gest, perhaps, that the Delavayellaceae evolved from the Scapaniaceae or from a common ancestor. However, there are major differences which suggest that any affinity to the Scapaniaceae is rather remote, among them: (1) the ability of the leaves to develop a postical, saccate, gibbous lobule which is so situated as to be somewhat appressed to the stem when the plant is dry; (2) the dorsal lobe tends to be larger than the ventral, although often subequal to the ventral; (3) the distal part of the leaf is explanate and flattened, with the lobes not conduplicate; (4) the gemmae are globose and unicellular and appear to be fundamentally different from the fasciculate, catenulate-produced gemmae of the Scapaniaceae.

VI. HYGROBIELLA Spruce and METAHYGROBIELLA gen. nov.

The genus *Hygrobiella* was based on the single species, *Jungermannia laxifolia* Hook. (Brit. Jungerm. Pl. 59. 1816). It has been placed, variously, in either the Ptilidiaceae (Evans, 1939) or the Cephaloziaceae (Trigonantheae, Trigonanthaceae), as in Müller (1905-16). More recently Müller (1948) proposed the family Hygrobiellaceae, of which *Hygrobiella* must be assumed to be the type genus. This family was stated to differ in lacking, *i.a.*, oil bodies in the leaf cells. Besides *Hygrobiella*, *Pleuroclada* and *Anthelia* were assigned to the family. Schuster (1949) accepted the family, and it has been rather generally accepted in recent years. However, in another connection, I shall attempt to show that *Anthelia* is not directly allied to the genera *Pleuroclada* and *Hygrobiella* and that these last two genera are best placed as a primitive subfamily of Cephaloziaceae in which the ventral merophytes retain the ability to develop relatively large underleaves. At any rate, *Hygrobiella* definitely has oil bodies in the leaf cells and thus does not conform to the concept of Hygrobiellaceae, as based on oil-body free taxa.

However we wish to dispose of *Hygrobiella*, the following points need to be kept in mind: (1) The genus is based on a plant in which there is an approach to isophylly, in that the underleaves are relatively large, although hardly equal to the lateral leaves in size; (2) the branches are lateral and intercalary, or postical and intercalary; the lateral branches issue from the ventral half of a leaf axil; (3) the leafy stems do not arise from stoloniferous bases, but *give rise* to stolons or flagella. If these criteria are applied, none of the other species assigned to *Hygrobiella* by Schiffner (1893), Stephani (1908, 1924), or Herzog (1950) can be retained in the genus *Hygrobiella*. Of the five species assigned by Stephani to *Hygrobiella*, in addition to *H. laxifolia*, one represents the genus *Eremonotus* (*Hygrobiella myriocarpa*), while a second, *H. japonica*

St., has been placed by Hattori (1952, p. 149) as a synonym of *Marsupella sphacelata!* Of the other four species, *H. australis* St., from New Zealand, does not belong in *Hygrobiella* ("*amphigastria caulina parva*"), while *H. macgregorii* St. and *H. mollusca* (De-Not.) St., from New Guinea and Borneo, respectively, certainly do not belong in *Hygrobiella.* They are stated to have "amphigastria caulina nulla." The fourth species, *H. dusenii* St. (1924), from Tierra del Fuego, is so poorly described that I cannot come to any conclusions as to its affinity. Obviously, Stephani did not have any clear concept of the genus *Hygrobiella,* even though he referred to it as a "höchst ausgezeichnete Gattung"—and compared it to the quite unrelated genus *Diplophyllum.* Herzog (1950, p. 292, fig. 10) described an additional new species, *H. acuminata* Herz., allied to *H. mollusca,* also without amphigastria. This is equally impossible to maintain in the genus *Hygrobiella,* even though it and its underleaf-free allies agree with *Hygrobiella* in the strongly elongate, thin-walled, large leaf cells and the bifid leaves, which are transversely inserted.

It has been a major problem in the clarification of the classification of the "Hygrobiellaceae" to decide where to place these underleaf-free species referred to *Hygrobiella.* It seems best to follow the suggestion of Müller (1954, *in* 1951-58, p. 583), who stated, "Sie gehören offenbar einer neuen Gattung zu," and to found a new genus for them, as follows:

Metahygrobiella gen. nov. Plantae foliiferae mediocres vel magnae, flaccidae, fragiles, pallidae vel glaucescentes, caespitosae. Folia caulina concava, transverse inserta, bilobata ad 1/3-2/3, lobis triangulis vel acuminatis. Cellulae leptodermes magnae saepe elongatae, 27-45 × 54-90 μ vel 40-45 × 100 μ, tenuissimae. Amphigastria nulla.

TYPUS: *Hygrobiella acuminata* Herz., Trans. Brit. Bryol. Soc. 1(4): 292. Fig. 10. 1950. **Metahygrobiella acuminata** (Herz.) comb. nov.

Plants generally sterile (rarely fertile), laxly caespitose, dioecious, small (stems to 1-3 cm. long, at times only 5-6 mm. long), *soft-textured and usually flaccid,* frequently quite pellucid. Stems soft, thick and rather fleshy, only 6-8 cells in diameter usually, of soft-textured leptodermous cells; the cortical cells as large as the medullary, not differentiated from them; plants sometimes rhizomatous or stolonaceous basally, and there freely rhizoid-bearing, with erect to ascending leafy branches which are nearly or quite rhizoid-free; branches lateral, always (or at least usually) intercalary, sometimes running out into flagella and attenuated. Leaves *subtransversely inserted* (at most slightly succubous), distichous,

loosely imbricate, typically strongly concave or subcanaliculate to conduplicate-concave, suberect to obliquely spreading, equally to unequally bilobed (if unequally, the antical lobe distinctly smaller) for 0.3-0.65 their length; lobes subacute and apiculate to (*M. acuminata*), longly acuminate, entire-margined. Underleaves lacking (or, in *M. australis*, small and entire). *Leaf cells exceedingly large, thin-walled and non-collenchymatous, becoming strongly elongate basally;* uppermost cells from 18-36 × 36-50 to 25-27 × 60-70 μ, the lower cells from 25-36 × 60-72 μ up to 40-45 μ × 100 μ. Asexual reproduction lacking.

Gynoecia terminal on stem, with subfloral innovation. Perianth subcylindric and sometimes (always?) thick and multistratose below, plicate above and there obtusely trigonous; mouth incised and denticulate to erose-dentate. Perichaetial bracts in a ring of three, suberect, oblong-obovate, canaliculate-conduplicate, shallowly to deeply bilobed, the lobes subequal, broadly to narrowly triangular and subacute to acuminate; bracteole similar in form and size to bracts. Male plant unknown. Sporophyte unknown.

Other species assignable here are the following: **Metahygrobiella mollusca** (DeNot.) comb. nov. *Jungermannia mollusca* DeNot., Hep. Borneo. 16. 1874. *Hygrobiella mollusca* (DeNot.) St., Hedwigia 34: 46. 1895. Borneo. **M. australis** (St.) comb. nov. *Hygrobiella australis* St., Sp. Hep. 3: 358. 1908. Arthur's Pass, New Zealand. **M. stolonacea** (Herz.) comb. nov. *Hygrobiella stolonacea* Herz., Trans. Brit. Bryol. Soc. 1(4): 293. Fig. 11. 1950. Borneo. **M. macgregorii** (St.) comb. nov. *Hygrobiella macgregorii* St., Hedwigia 34: 46. 1895. New Guinea. Also described by Stephani (Sp. Hep. 6: 444. 1924) is a *Hygrobiella dusenii* from Tierra del Fuego, which is diagnosed in such a misleading and ambiguous manner that its generic position cannot now be established. However, this probably also represents a species of *Metahygrobiella*.

Metahygrobiella is one of the most poorly known genera of the leafy Hepaticae owing to a lack of careful study of stem anatomy and branching patterns and the scarcity of adequate material for study; only *M. australis* and *M. mollusca* are known with perianths—and none of the species is known with androecia or capsules. The single species referred to the monotypic and northern genus *Hygrobiella* agrees with *Metahygrobiella* in some important respects: the perianth is trigonous above (at least in *M. australis*); the gynoecium bears three bracts—or more correctly, a pair of bracts and a bracteole that are similar in size and form; the bilobed and essentially transversely oriented leaves are formed of exceedingly leptodermous and delicate cells, and the basal cells become

notably elongated. The stem is soft-textured; the gynoecium occurs apically on a long branch and stolons or flagella may be formed.

However, there are major distinctions between *Metahygrobiella* and *Hygrobiella* that quite preclude the two groups being considered intimately related. (1) *Metahygrobiella* either lacks underleaves entirely or has minute ones, thus is distichous; *Hygrobiella* is almost isophyllous and tristichous, with large underleaves that approach the lateral leaves in size and form. (2) *Metahygrobiella* has the cortical cells similar in diameter to the medullary cells, with the cortical and medullary both thin-walled; in *Hygrobiella* I find that there is a distinct hyaloderm layer, the cortical cells being leptodermous and 30-35 μ in diameter, contrasted to many rows of smaller and somewhat thick-walled medullary cells that are more strongly elongate and are only 10-15 μ in diameter. The stem anatomy of *Hygrobiella* closely approaches that of primitive species of *Cephalozia*, such as *C. pleniceps*. (3) *Metahygrobiella* has much larger and more delicate leaf cells, with the cells ranging from (18)20-36 × 35-70 μ medially, the basal 25-45 × 60-100 μ; in *Hygrobiella* the median cells are ca. (14)17-23 × 35-55 μ, the basal 20 × 40-70 μ. Careful comparison of adequate fertile material of *Metahygrobiella* with *Hygrobiella* will, I am sure, result in discovery of an additional ensemble of distinctive characters.

The distichous organization of the vegetative shoot sectors but tristichous, isophyllous organization of the gynoecium, the trigonous perianths, together with the large and leptodermous cells and the soft-textured stem without a thick-walled cortex, and the ability to develop stolons suggest that *Metahygrobiella* must be placed in the Cephaloziaceae. The presence of perianths on elongate shoots suggests *Hygrobiella*, however. But, it should be noted, such primitive species of *Cephalozia* as *C. bicuspidata* may have the gynoecia on exceedingly elongate, leafy branches. This, together with the probably distinct, if diffuse relationships between *Hygrobiella* and *Metahygrobiella*, suggests that the family Hygrobiellaceae should be discarded, a thesis which will be explored in more detail in another connection.

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NOTES ON NORTH AMERICAN SPHAGNUM. XIII. SPHAGNUM PYLAESII

A. LEROY ANDREWS[1]

In the first place the above is the original spelling of the specific name[2] which has generally been followed in American literature. In European literature one finds *Pylaiei*, going back to a correction of Lindberg (the same who corrected *Lescuraea* to *Lesquereuxia*). It would seem that an author should have considerable latitude in latinizing a personal name and his spelling should stand as long as no definite mistake has been made. The name is of course based upon De La Pylaie, who furnished Bridel with the original plants, but the *s* in the genus *Pylaisia*, named after the same person, has not raised objections and still survives.

The species is distinct enough, though even its author thought it might be a form of *S. cymbifolium* (*palustre*), and C. Müller in

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[2] Bridel, Bryol. Un.v. 1: 749. 1827.

his *Synopsis Muscorum* (1:92. 1848) did not yield it an independent place at all but treated it as a mere form of *S. cymbifolium*, with which it is now clear it is not at all closely related, though it has some analogous features.

Its characters, as compared with the other species, are of a strangely negative order. In the first place it doesn't look much like a *Sphagnum*, especially in its common simplex form (var. *sedoides*). It is generally of various brown shades to nearly black in color, does not always grow erect, and in its semi-aquatic habitat may almost suggest some member of the Amblystegiaceae or Fontinalaceae. If it produces branches they are not numerous, either single or not more than three at the most in a fascicle, with no great difference between spreading and pendent ones, if pendent ones in the ordinary sense can be said to occur. The stem leaves then play the main rôle, are numerous and imbricate, isophyllous with hyaline cells fibrillose throughout and a border of narrow cells, differing from the branch leaves essentially only in the several times larger size. They are very cucullate, so that they can hardly be flattened under a cover glass without splitting at the apex, which is probably the reason why they were associated with *S. palustre*. The hyaline leaf cells are generally said to be without pores, but I have sometimes detected pores in the ends of hyaline cells on the ventral surface of the leaf, still more rarely in the lateral corners or on the dorsal surface of the leaf. To make up for the lack of definite pores there is extensive resorption of membrane on the dorsal leaf surface. Lindberg had already noted the resorption gaps in the apical region of the leaf, another analogy with the species of the CYMBIFOLIUM group. They are not always confined to the apical part, but may occur in some cells well toward the base. They are often large, covering all or nearly all the space between cross fibrils and especially favoring the broadest central part of the cell. Where the membrane is not resorbed it often shows membrane pleats, described and figured by Warnstorf.[3] Warnstorf also noticed that the narrow-celled leaf border tends to be hyaline. This is also due to membrane resorption, especially of the outer surface, leaving the border remnant a mere shell, often elusive or indeterminate, but without the teeth and resorption furrow of, for example, *S. tabulare*. Sometimes among its elongated narrow cells one finds some with attenuated cross fibrils, showing that the normal alternation of hyaline and chlorophyll cells passes gradually into the border, in contrast to the usual sharp distinction in the LITOPHLOEA species. Already the original description noted that the fibrils of the hyaline leaf cells are rings rather than the normal

[3] Sphagnologia Universalis. 18, fig. 6.

spirals. They were also found peculiar in that they project farther into the cell as bands or disks, leaving an unusually small opening in their center. In the cucullate leaf apex the hyaline cells are greatly shortened and broadened, leaving a strangely distorted areolation of resorbed hyaline cells, cross fibrils and irregular chlorophyll cells jumbled together. In section the chlorophyll cells of the leaves, as Lindberg already described them, tend to be slightly more exposed on the inner surface as in *S. cyclophyllum,* with lumen also broader toward that side.

The inflorescence is dioicous and fruiting is rare, or so inconspicuous as to be rarely noticed. For many years Austin had the distinction of being the only person to have found it in fruit. His specimens are dated June 16, 1869 and were collected at Batsto, New Jersey. In 1911 after work on *Sphagnum* at the New York Botanical Garden I decided to spend a short time at Toms River and vicinity, New Jersey, with the vague hope of duplicating Austin's experience. The hope was realized, my specimens bearing the date of August 5. They were growing at the edge of a pond where they were apparently inundated at times. I put some of them in the sun to see if they emitted their spores with the characteristic explosive burst of normal *Sphagnum* species and found they did not, the capsule and operculum separating about as in other gymnostomous mosses. Instead of the capsule contracting into subcylindrical form it rather broadened at the orifice, the opercular part, which was of nearly the same size and consistency, behaving likewise. Some of the spores were thrown out in the process of separation, but were not shot into the air. Lindberg, who had seen Austin's specimens, described the sporophyte in its essential features and was so impressed by its differences from the normal *Sphagnum* sporophyte that he made the species, first alone and later together with *S. cyclophyllum,* a section, subgenus or almost a genus HEMITHECA,[4] as I have previously indicated.[5] The perichaetial leaves are larger than normal branch leaves, more like the stem leaves in size, but otherwise like both with fibrillose hyaline cells throughout as in *S. cyclophyllum.*

The capsule peculiarities are well described by Lindberg as noted in my paper on *S. cyclophyllum.* Especially striking is the absence of pseudostomata, which, so far as known, are present in all species of *Sphagnum* except the two in question. The precise function of these pseudostomata has never been cleared up. They certainly do not function as ordinary stomata, but their presence in the capsule wall and their general formation leaves it difficult

[4] Braithwaite, Sphagnaceae. 85. 1880; Lindberg, Hvitmossor. 6 ff. 1882.
[5] Bryologist 63: 230 ff. 1961.

to conceive of them as other than at least homologous to these organs. Schimper in the beautiful illustrations of his pioneer monograph on *Sphagnum*[6] shows them and both calls them stomata and treats them as if they were such. As they are lacking in the two species which do not expel their spores explosively one might naturally assume that their presence has something to do with the capsule contraction which precedes the expulsion of the spores. They offer no penetration of the capsule wall, which would prevent the compression of the air or gas in the capsule leading to the explosive expulsion of the spores. Very valuable is the treatment of these pseudostomata by Mrs. Jean Paton,[7] who accompanies her description by revealing microphotographs and drawings. I had devoted considerable study to them, including sectioning, prior to my 1913 publication and I find my notes, as far as they go, covered and further explained by Mrs. Paton. Of interest is the number of these per capsule, which she found to vary by species, as already Schimper had indicated. She confined her research to British species and so did not have available the two species lacking them and apparently also had not studied *S. imbricatum*, which I found to have the greatest number of them. I had estimated that there might in this species be a thousand or more pseudostomata on a single capsule. This may seem grossly exaggerated, as it did even to myself when I reviewed my notes, but Mrs. Paton figured 400 for a capsule of *S. papillosum*, and I had also studied the latter species and found that it had definitely less than *S. imbricatum*, and so it may be safely stated that a single *Sphagnum* capsule may in extreme cases contain somewhere from 500 to 1000 pseudostomata. Mrs. Paton said 100-400, never less than 100. They are irregularly scattered over the surface of the capsule, except that they are lacking in a belt about the orifice and also in the basal portion—that is, they are present only in that part which contracts to bring the capsule into subcylindrical form and compress the contained gas for the explosive discharge of spores. In both *S. imbricatum* and *S. papillosum* I found a case where two pseudostomata were joined together. As differing from normal stomata, what should be the guard cells do no guarding; instead of being strong they are decidedly weaker than anything about them and easily subject to folding, separating or rupturing. They enclose no definite pore, but according to Mrs. Paton's drawing may separate, possibly in some connection with the capsule contraction. But in-

[6] Versuch einer Entwicklung der Torfmoose, 1858; also in French, Mémoire pour servir à l'histoire naturelle des Sphaignes, 1857.

[7] Transactions of the British Bryological Society 3: 228 ff. 1957; the paper is by Jean A. Paton and Jean V. Pearce, but as the junior author had only contributed to the physiology, I am referring to Mrs. Paton as author.

stead of affording penetration of the capsule wall they form the outer cover of a cup-shaped depression in the capsule wall, this depression having otherwise thickened and impenetrable walls. That these pseudostomata at an earlier stage of development may be normally functioning stomata is a quite gratuitous assumption and unlikely, but a detailed study of their development in the immature capsule remains a desideratum.

The explosive discharge of the *Sphagnum* spores has often been noticed, reportedly already by Linnaeus and has been variously referred to or described in literature. The classical treatment is by Nawaschin,[8] from which it is evident that air or other gas (Nawaschin says air) in the capsule is compressed by lateral contraction of the capsule walls until the pressure sends the operculum and spores several centimeters into the air; Nawaschin says up to 10 cm. In preparation for this the capsule is raised above the *Sphagnum* capitulum by elongation of the pseudopodium so that the spores have unrestricted access to any current of air that can transport them to other areas. This whole mechanism is lacking in *S. Pylaesii* and apparently also in *S. cyclophyllum*, whether as a primitive condition or more likely through degeneration. In fact, *S. Pylaesii* has much the aspect of a degenerate species, though its much broken distribution shows that it is an old species. If one were to attempt to label its general distribution, one would doubtless call it an Atlantic species, as it occurs on both sides of the Atlantic and on neither side is it found very remote from the Atlantic coast. On the European side it is even more restricted than on the American. For a long time it was known there only from the Bretagne peninsula of France, from which it was reported at the same time as the Newfoundland type under the separate name, *S. sedoides* var. *prostratum* Brid., the specimen also credited to De La Pylaie. It was rediscovered there later by Camus and has since been collected at the original and other nearby localities by various botanists, my specimen at the type locality by Dismier. In more recent times Casares-Gil found it in Spain,[9] and P. Allorge was able to add three other Spanish localities.[10]

In America it is more widely distributed, but the broad outlines of its distribution have not been greatly changed since my treatment of 1913. Labrador specimens were collected and distributed by Waghorne. In Newfoundland, besides the original collection of De

[8] Flora 78: 151. 1897. A popular description, cited by Paton and Pearce, is given in C. T. Ingold, *Spore discharge in land plants*, pp. 105-108. Oxford, 1939.

[9] Bol. R. Soc. Esp. Nat. Hist. 20: 225. 1920.

[10] Bol. R. Soc. Esp. Nat. Hist. 27: 457. 1927; Rev. Bryol. et Lichénol. 7: 267: 1934.

La Pylaie, it has been found by several later botanists. On the neighboring islands of St. Pierre and Miquelon, apart from earlier collections by Delamare, Father Le Gallo during his stay on the islands through the years 1942-45 found in very many localities well developed branched specimens, but no sporophytes were detected. In Nova Scotia Nichols found it on Cape Breton Island, as had already Macoun, and later Miss Margaret Brown at several localities about Halifax. In Maine the classical locality is Mt. Desert Island, where Rand in his thorough investigation of the island's flora (1894) found it at several places, including summits of the elevations known locally as mountains. Probably the easiest place to see it growing now is around the parking area at the summit of Mt. Cadillac on Mt. Desert Island, if indeed it has not already been destroyed there by tourist traffic. In New Hampshire it was collected at Ethans Pond, Mt. Willey, by James, later by Faxon, on Chocorua by Farlow. These stations are in the White Mountains, considerably removed by distance and altitude from the coast and present accordingly about the same problem as the stations in New York State. From Massachusetts there is a specimen in the Austin Herbarium said to have been collected by Ingraham at New Bedford, received by Austin from James. Unfortunately my note of this occurrence was discovered too late to be incorporated in Dr. Hilferty's checklist. It is from the same locality as the reported occurrence of *S. cyclophyllum* and might suggest that the latter report was based upon mistaken identification of the *sedoides* form of *S. Pylaesii*, though both may have been growing together as in New Jersey. It is lacking in Rhode Island and Connecticut and in New York State on Long Island, where many of the Atlantic species, even to a recent find of *S. portoricense*, do occur. Its occurrence in New York, on the other hand, is strangely confined to a limited part of the Adirondacks, which is quite remote from the coast by distance and elevation. It was found on Mt. Marcy by Torrey in the *sedoides* form, according to Lesquereux and James, and collected extensively there and in the vicinity by Peck and various collectors. Localities indicated by labels are, apart from the summit of Mt. Marcy and Lake Tear, Lake Avalanche, Arnold Lake, and a number of collections from the summit region of the neighboring Mt. McIntyre. A collection by Coville at Second Lake, North Branch of Moose River, is noteworthy. It has not been found, for example, on Mt. Whiteface or other Adirondack areas than those mentioned. This isolated mountainous occurrence of the species might suggest a nunatak survival at least through the Wisconsin glaciation. In New Jersey it is again a coastal species, confined to the pine barren region, the only area in which sporophytes

have been found. Apart from the Batsto and Toms River localities already mentioned it was distributed from Pleasant Mills, collected by Eaton, and there is a more recent collection by E. C. and G. M. Leonard from a quaking bog along a branch of Wading River south of Chatsworth.

There are no coastal plain stations south of New Jersey, the limited finds being there again in the mountains. One of the earliest stations was at "Table Rock," South Carolina, credited to Asa Gray and to Lesquereux by Lesquereux and James, from which specimens were distributed in the Sullivant and Sullivant and Lesquereux exsiccati as *Sphagnum sedoides*. The later collection (1896) by Small from summit of Table Mt., South Carolina, was presumably from the same locality. Recently (1951) it was found by Anderson at the Devil's Courthouse in Jackson County, North Carolina, a similar table-top mountain (4400 ft. alt.). Sharp had also found it (1937) in Tennessee near the top of Mt. LeConte (6300 ft.). Only the *sedoides* form is found in these southern localities. The localities are again mountainous and removed from the coast as in New York and New Hampshire. They are also not very close together, and both Dr. Blomquist and Dr. Sharp inform me that with all the bryological activity of recent years in the southern mountains no other additions have been made. Here it is of course not a question of glacial survival, as possibly in the Adirondacks of New York or the White Mountains of New Hampshire, but of survival as such. In fact, the very broken and irregular distribution of *Sphagnum Pylaesii*—and not much new discovery is likely to be added—is clearly a relict distribution.

The species certainly belongs in the subgenus LITOPHLOEA, in spite of some analogies with the subgenus INOPHLOEA and apparrently to the series CUSPIDATA as I have defined it, including *S. subsecundum*. The general assumption that it is most closely related to *S. subsecundum* through *S. cyclophyllum* can hardly be refuted, but it must be emphasized that there are no intergrading forms even with the latter species, and such points of difference that Lindberg's subgenus HEMITHECA can hardly be maintained as a natural subdivision.

STUDIES ON THE MOSSES OF LURAY CAVERN

PAUL V. PRIOR[1]

Specific references to bryophytes associated with caves are relatively scanty. No doubt many distribution reports have omitted the fact that collections were made in or around the mouths of caves. Only a few mosses such as *Schistostega* and *Tetrodontium* are well-known cave inhabitants. Lammermayer (1912) gave a comprehensive discussion of studies made on bryophytes of 48 caves in Austria. His list contained 72 species with a short description of the ecological conditions for each. The genus *Eurynchium,* with six species represented, occurred in the greatest number of caves. *Eurhynchium praelongum* was found to be growing in 1/560 of the available light at the cave entrance. If this represents a fraction of full sunlight, although not so stated, the illumination would have been only about 20 foot candles. Maheu (1926) collected in the mouths of Mammoth, Great Onyx, and Crystal caves in Kentucky. His list included six mosses and one hepatic; *Anomodon* (*Leskea*) *attenuatus, A. rostratus, Brachythecium rivulare, Eurynchium praelongum, Gymnostomum calcareum, Mnium rostratum,* and *Marchantia polymorpha.* The plants were described as etiolated, with considerable morphological modification, and lacking sporophytes. He observed that the bryophytes in all three caves were identical and were the same genera included in studies made in Europe. *Marchantia polymorpha* was found in the least light intensity and showed the least morphological variation from normal plants. No light values were given. Ammons (1933) collected 44 liverworts and 46 mosses from the mouth of McKinney's cave in Preston, West Virginia. Several caves in Hanover and Hessen, Germany, were investigated by Grebe (1918). It was noted that collections were made from 5 to 10 meters from the cave mouth and that these plants were growing in very dim light that reflected in from the surface. Although a list of species was not included, he mentioned the presence of thick mats of *Amblystegium juratzkanum* around electric light in the Dunkel der Deckenhöhle at Iserlohn.

A few references have been made to mosses growing in the illumination of electric lights alone. Thomas (1897) was sent a collection from the Decklenhöhle which he determined to be *Rynchostegiella tenella* var. *cavernarum.* According to the report, this moss developed in front of lights that had been in use about a year. An incidental remark in the paper noted that this species,

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togther with *Rynchostegium algerianum*, had been collected from underground rooms in the Roman Colosseum. *Bryum capillare*, *Brachythecium velutinum*, and *Rynchostegium murale* were found in the dim electric lights of Hermannshöhle and Baumannhöhle near Blankenburg, Germany (Verdoorn, 1927). The plants were described as small and etiolated, with crumpled leaves; no mention was made of sporophytes.

A small amount of *Fissidens taxifolius* was collected from the damp ceiling of Crystal Cavern, Virginia. It was growing in an 8-inch circle around a light bulb (Conard, 1932).

Thatcher (1949) reported on the bryophytes growing around electric lights in Crystal Cave, Wisconsin. He listed, in collections from eight colonies, *Marchantia polymorpha*, *Fissidens taxifolius*, *Ceratodon purpureus*, *Barbula unguiculata*, *Didymodon recurvirostris*, *Leptobryum pyriforme*, *Bryum caespiticium*, *B. capillare*, *Mnium cuspidatum*, *Leptodictyum riparium*, *Drepanocladus fluitans*, *Brachythecium salebrosum*, and *B. populeum*. A small amount of the fern *Cryptogramma stelleri* was present, with prothalli. Only a single sporophyte, on *B. caespiticium*, was found. The colonies ranged from 3-24 inches from the light source in an intensity of 25-850 foot candles.

Lundegårdh (1931) had an interesting note on the zonation of plants he observed around electric lights in caves near Macocha. Ferns grew closest, mosses farther away, and algae farthest from the lamps. No species were given or any measurements taken.

Verdoorn (1932) offers the opinion that the very dim light conditions may be offset by the higher carbon dioxide content of the limestone cave atmosphere. Investigation of this relationship should prove very enlightening.

The limestone underlying the Shenandoah Valley of Virginia is honeycombed with caves, a number of which have been open many years as tourist attractions. Only one of several investigated during the summers of 1958 and 1959 has a luxuriant growth of several mosses in front of the floodlights used to illuminate the numerous rock formations. This cave, the Caverns of Luray, is located at the western edge of Luray, Page Co., Virginia. Through the courtesy of Mr. Ted Graves, owner of the Caverns, I was permitted to collect specimens and study the ecology of the plants in the various halls and passages during the summer of 1959. It was certainly fascinating to find a total of ten mosses and one fern growing successfully at many stations 200 to 400 feet below the earth's surface.

The cave lies in what is geologically known as the Nittany dolomite of the Beekmantown group (Butts, 1933). The approxi-

mately one and a quarter miles of passageway now open to the visitor forms a figure 8, passing through tunnels of solid rock as well as several thick deposits of silt carried in by underground streams. (A description of the chemical nature of the parent rock is included in the ecological discussion below.)

Collections were taken at each of 33 stations illuminated by floodlights. The investigation was carried out in order to report the species represented in this unusual habitat, to determine the ecological conditions under which these plants were thriving, and to study the development of mosses under certain controlled conditions that the natural substrate and atmosphere of the cavern provide.

All the species listed have been reported from the general area by authors treating the bryophytes of Virginia (Patterson, 1949, 1950; Prior, 1959). In the alphabetical notations below, the frequency of species distribution in the cave is given. All the collection numbers cited in parentheses are my own. Specimens have been placed in the herbarium at Texas Technological College, as well as my personal collection. Specific references to collection stations were taken from names listed in the sketch map by McGill (1933).

Mosses

Amblystegium serpens (Hedw.) BSG. (787.) On wet limestone at only one station near Specimen Hall, forming a loose mat. Sporophytes present.

Anomodon rostratus (Hedw.) Schimp. (791.) In two locations, on moist limestone near Bridal Veil Falls and on silt near Tall Man's Misery Tunnel. Associated with *Leptobryum pyriforme*. Not fruiting.

Bryum bimum (Brid.) Turn. 733.) In fairly dense mats on moist limestone at four stations. A pure stand of gametophytes was found in Tunnel Pass; this moss was mixed with *Leptobryum pyriforme* at the other three locations. Not fruiting.

Campylium hispidulum (Brid.) Mitt. (779.) On moist limestone and silt at eight widely scattered stations. Growing as a single occupant at five stations and mixed with *Leptobryum pyriforme* and/or *Eurhynchium hians* at the remaining three. Gametophytes bore sporophytes at three locations.

Desmatodon obtusifolius (Schw.) Jur. (768.) One collection from Statuary Hall, on wet limestone. A rather large and dense mat bearing only two sporophytes.

Eurynchium hians (Hedw.) J. & S. (802.) A very abundant moss collected from 19 of the 33 stations in the cave. It occurs on wet limestone either as a pure stand or mixed with several other species. Three collections showed abundant sporophytes.

Fissidens minutulus Sull. (794.) Only one collection from moist limestone near the memorial plaque at the cave entrance. A small amount of this moss was found associated with *Eurhynchium hians*.

Funaria hygrometrica Hedw. (776.) A single collection of this moss, mixed with *Leptobryum pyriforme*, was obtained from moist limestone in the vicinity of Titania's Veil. The presence of numerous sporophytes of *Funaria hygrometrica* and the absence of sporophytes from *Leptobryum*

pyriforme should be noted. Incidentally, this station is the only collection site subjected to greater light intensity provided by two 200-watt bulbs.

Leptobryum pyriforme (Hedw.) Schimp (780.) On moist limestone and silt at a total of 18 stations in the cave. This is the most abundant and most widely spread of all the mosses listed. It occurs as pure stands as well as mixed with several other species. Numerous sporophytes were found at ten of the 18 collection stations.

Leskea polycarpa Hedw. (783.) On wet limestone at the edge of an underground lake in Silver Sea Corridor. Only a small amount mixed with *Leptobryum pyriforme*.

FERNS

Dryopteris thelypteris (L.) Gray. Collections were made at three widely spread stations; the Plaque, the Ballroom, and Tunnel Pass. In addition to well established sporophytes, there were numerous prothalli in various stages at each collection site. (I was assured by the management that this was a natural development.)

The cave entrance is covered by a building; consequently the atmospheric conditions are constant throughout all of the passages except in the immediate vicinity of the lights. The air temperature of the cave is 12.2° C. The maximum temperature at the point of moss growth nearest the lights is 24° C. However, at a majority of stations the temperature is 20° at that spot. Air temperatures at all stations uniformly diminish with distance from the lights to between 12.2° C. and 14° C. at the farthermost point of leafy gametophyte growth. At a majority of the stations the minimum temperature at that point is 14° C. Therefore, maximum to minimum growth range is 12.2° C. to 24° C.

The relative humidity of the cave atmosphere is 88%. To what extent the humidity decreases with increasing temperature near the light bulbs could not be determined. It is doubtful, however, that this is a significant factor in the growth and development of moss plants because no difference could be detected in plants growing near the lights and those farther away. Furthermore, at stations where more than one species was collected there was no consistent zonation of the various species.

Illumination is provided by 150-watt light bulbs and 150-watt floodlights enclosed in reflectors. At all except one station only a single bulb or floodlight is used; at this station there are two 200-watt bulbs. Measurement of light values in foot candles was obtained by converting the scale of a Weston Master III exposure meter and multiplying by a factor of four as recommended by the manufacturer. In order to determine the accuracy of this method, the same meter was checked against an accurate direct reading photoelectric meter. The error was found to be approximately 4%, too small to warrant consideration within the limits of this study.

The substrate, as already mentioned, is Nittany dolomite. At some stations the mosses were found growing on rock while at others they were collected from cave earth. The rock is a gray magnesian limestone, thickly bedded, containing siliceous lenses here and there. An analysis of this formation from rock collected in Luray Caverns was reported by Butts (1933). The following composition was given: Al_2O_3 and Fe_2O_3 3.48%; $CaCO_3$ 76.5%, $MgCO_3$ 13.09%, and an insoluble residue (presumably siliceous material) 9.07%. The pH of water and cave earth material at collection sites ranged from 7.2 to 7.8. This was determined by a Beckman pocket model, electric pH meter.

Considering other factors to be reasonably constant, the primary variable in the cave environment is light. This situation lends itself quite well to an evaluation of the effect of light intensity and position on the development of moss gametophytes. Since the lights are used to illuminate cave formations dramatically, they are seldom moved even when the bulbs are being replaced. According to the management, the present lighting system was installed in 1921. About five years ago it became common practice to permit the lights to burn continuously throughout the cave rather than illuminate each area only during the passage of a party. No doubt this has contributed to an extensive development of mosses in an extended period of illumination. Although several of the guides reported seeing green growths which they called moss as long as 15 years ago, there is some question as to whether they were truly moss or algae. In any case, the noticeable patches of moss seem only to have developed within the past few years.

The moss growth is a fan-shaped arc of plants whose marginal development is sharply defined. The lateral limits of each patch of moss are controlled by the angle of the reflector, whereas the distal limit of growth is apparently controlled by the diminution of light intensity to the minimum limit. At this point the cessation of plant growth is quite sharp. Irregularities in the slope in most cases are not abrupt enough to cause much marginal scalloping.

Maximum illumination provided by the lights varies from 1800 to 2400 foot candles at the point of moss growth nearest the bulbs. Minimum readings at the periphery of the growth arc are approximately 40 to 50 foot candles. Three species were not included in this part of the study because of insufficient development of the moss. A resumé of collections and light ranges are included in TABLE 1.

The individual plants display a marked growth change with increasing distance from the lights. The phototropic response is quite striking in that the acrocarpous forms were inclined as much

TABLE I. Species collected, sporophytes present and light intensity range.

	Total no. of collections	No. of collections with sporophytes	Light intensity in foot candles	
			Max.	Min.
Amblystegium serpens	1	1	No results	
Anomodon rostratus	2	0	2000	48
Bryum bimum	4	0	2400	140
Campylium hispidulum	8	3	2400	40
Desmatodon obtusifolius	1	0	1800	55
Eurynchium hians	19	3	2400	48
Fissidens minutulus	1	0	No results	
Funaria hygrometrica	1	1	2000	40
Leptobryum pyriforme	18	10	2200	52
Leskea polycarpa	1	0	No results	

as 75° from vertical at the farthest point of moss development. Since some of the lamps lie on the ground, this response is evident throughout the growth. Sporophytes on *Leptobryum pyriforme* are inclined to the same extent as the stem of the gametophyte.

All the species listed display some degree of etiolation with increasing distance from the lamps. The number of chloroplasts remains approximately the same at all intensities; therefore, the pallid condition of the plants results from a reduction in chlorophyll.

Both leaves and stems show radical changes in structure with decreasing light. The leaves of the mosses are much more crisp and are somewhat shorter and narrower than normal. Those of *Leptobryum pyriforme* are only about two-thirds as wide and three-fourths as long as leaves on normal plants. The tips of the leaves are considerably more attenuated. With increasing distance from the lights there is an increase in internodal length to approximately twice that of normal plants. In general, the increasing etiolation with diminishing light intensity is comparable to the growth response of flowering plants.

In assessing the success of the plants growing in the conditions described, it should be noted that five of the ten mosses and the fern developed both gametophytes and sporophytes. Only *Funaria hygrometrica* did not produce abundant sporophytes. In the case of *Leptobryum pyriforme* and *Campylium hispidulum*, over half of the collections included sporophytes. Plants at the very outside edge of the growth arc were not found to be fruiting. This, of course, brings up the question of whether the absence of sporophytes is caused by the dimness of the light or whether the plants were too youthful to have developed sex organs. The latter is un-

doubtedly true in some cases where the growth had not reached the limit of light intensity determined as the minimum for that species.

In order to follow the sequence of moss growth, lights were installed in an unused room in the cave. This room, Miller's Hall, was closed to the public in 1926. Since that time it has been only infrequently visited by workers. Two lights in reflectors, similar to those used throughout the cave, were placed on the floor of this room on June 16, 1959. Nothing else was done to disturb the growth conditions. Frequent visits were made to the experimental site until the last of August. Every reasonable effort was made to avoid accidental introduction of spores other than by air currents.

Inspection of the area in front of the lights revealed the growth of what was presumed to be algae within two weeks. This growth did not extend beyond 12 inches from the lights. Moss protonemata obviously also were initiated, but how soon could not be determined. By August 26, however, recognizable gametophytes of *Leptobryum pyriforme* were found in a small clump about eight inches from one light. On December 10, 1959, collections and measurements were made by Mr. Grafton Campbell, an employee at the Luray Caverns. These collections contained *L. pyriforme* only, and the growths had spread to the edge of the reflectors and outward to about 14 inches. Both lighted areas had a fairly heavy moss growth.

Although it had been my intention to continue frequent observations in the summer of 1960, other commitments made it impossible for me to visit the cave. Collections made during the ensuing year contained gametophytes of *Leptobryum pyriforme*. Finally it was decided that the study would be concluded with the appearance of the first sporophytes.

On November 16, 1960, final collections were made and the lights dismantled since a large growth of gametophytes had developed before both lights and several sporophytes had matured on *L. pyriforme*. By this time the growth had extended to approximately 24 inches from the reflectors. In addition to the extensive growth of *L. pyriforme*, collections also contained a considerable amount of *Bryum bimum* and a small quantity of *Amblystegium serpens*.

The fact that both *Leptobryum pyriforme* and *Amblystegium serpens* were found fruiting in other parts of the cave provides a relatively simple explanation for their growth in front of the experimental lights as a result of spore transfer. However, a healthy growth of *Bryum bimum* in the same spot without any apparent spore production leads one to wonder how long the spores

had been viable and present at this spot or if they had only recently been carried in from the outside and how.

While the cave probably does not provide optimum substrate and atmospheric conditions for the growth of the mosses studied, the low light readings reveal the minimum light requirements for these mosses rather well. Development of large clumps of moss in the cave with no more preparation than installation of lights shows clearly how widespread the disseminules of these plants must be.

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A CHECKLIST OF THE MOSSES OF THE STATE OF ARIZONA

INEZ M. HARING[1]

The state of Arizona is located in the southwestern part of the United States and is bounded on the north by Utah, on the east by New Mexico, on the south by Sonora, Mexico, and on the west by California and Nevada, with the Colorado river here separating

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these states from Arizona. The state is approximately 350 miles square, including within its boundary about 115,956 square miles. It lies between latitude 31°20′ and 37°N. and longitude 109°31′ and 114°54′W.

The extension of the Mexican Cordilleras from the south divides the state diagonally into two sections, the southwest, which is low, and the north, which is an elevated plateau. This gives rise to three types of area—the Great Colorado Plateau in the north; the broad zone of compacted mountain ranges, running southeast to northwest; and a region of desert plain in the southwestern part of the state. In southern Arizona the eastern and the western parts differ. The eastern part is a rather high plateau, and from it rise the Chiricahua, the Huachuca, and the Santa Rita mountains, some of which attain a height of 9000 feet. The plateau, in general, is made up largely of arid grassland. On the upper slopes of the higher mountains are pine and other conifers, while oak and juniper come in at a lower altitude. The Sonoran Desert, which extends over the southwestern part of Arizona, reaches eastward so as to take in the Santa Rita valley near Tucson. Here the desert mountains stand out by themselves, often individually, with abrupt, sharp faces. The dry washes (river beds) through these areas make for splendid collecting. It is here that one is likely to pick up *Crossidium*, *Pterigoneurum*, and *Acaulon* growing along the edge of the wash under what shrubs and low bushes exist. For months at a time these streams at the base of the mountains are dry and empty, but at the period of the summer and winter rains they gather much water, which almost immediately runs off, leaving the surface dry, but sometimes leaving enough water below the surface for the vegetation to exist.

The altitudinal range of the whole state is great. At Yuma, in the southwestern corner of the state, there is an almost sea-level altitude. In the San Francisco mountains in the northern part of the state Humphrey's Peak reaches a height of almost 13,000 feet.

Temperature and moisture throughout the state are exceedingly variable, playing a great part in the establishment of all plant life. In the desert the sun shines all day, producing a hot, dry atmosphere as well as a long day. In the mountains with their canyons, some very narrow where not a ray of sunshine can penetrate, others wider where the temperature is moderated and the moisture increased, the environmental factors contrast strongly with the open desert. In the desert the moisture is scant, while in the mountains there is a strong variation, largely owing to the amount of water that seeps through the canyon walls and to whether the water in the streams at the base of the mountains is permanent or transient.

The forests of the state are quite extensive on the plateaus and on the mountain sides, which again make for ever-changing conditions.

These varied and numerous topographical features form an interesting background for the study of plant science in any form, whether it be algae, mosses, lichens, or flowering plants.

There are 14 counties in the state: Apache, Cochise, Coconino, Gila, Graham, Greenlee, Maricopa, Mohave, Navajo, Pima, Pinal, Santa Cruz, Yavapai, and Yuma.

Considered as a whole, there has been little collecting of mosses in the state. There are some records of early, scattered collecting but none of any great intensity. In recent years the outstanding collector has been E. B. Bartram, a one-time resident of Tucson, who recorded over 200 species collected within a radius of 60 miles of Tucson. Many of the species were new and were named by him. His exsiccati of this region are outstanding and represent the excellence of the work he did. Elzada U. Clover and Lois Jotter (1944) reported in "Floristic studies in the Canyon of the Colorado and tributaries" 19 species of mosses. In 1958 three of us went down the Havasupai Canyon, which was one of the canyons they worked in, and were able to find all but one species that they had collected plus several more. In 1951 James A. McCleary listed 351 species, varieties and forms as having been collected within the state. In 1953 he added a few more to this list.

The work of the author began in 1940 when a month of collecting was spent at the Grand Canyon National Park, with headquarters at the museum, the purpose being to start a herbarium of mosses of that area. Thirty-one species were then collected. In 1944 another month was spent there, adding 34 species to those already collected. In November of that year the University of Arizona at Tucson suggested that I come there and set up a herbarium of the mosses of the whole state, which I did, and since then alternate winters have been spent at the University working on the mosses of Arizona. In 1947 a checklist of 209 species, varieties and forms was published, followed in 1954 by a second list numbering in all 351 species, varieties and forms. In these years, with the help of Dr. W. S. Phillips, head of the Botany Department of the University of Arizona, the southern part of the state and some of the northern part have been fairly well covered. In 1957 I was invited to come to the Research Center of the Museum of Northern Arizona at Flagstaff to make for them a herbarium of the mosses of northern Arizona only. Since then, whenever I have come west to work on mosses, two months in the spring and in the fall have been spent in the northern part of the state. The winters

were always spent at the University of Arizona at Tucson. With the assistance of Dr. E. B. DANSON, Director of the Museum of Northern Arizona, the northern part of the state has been fairly well covered: the Carrizo, the Lukachukai, Roof's Butte, the Chuska, the Navajo, and the Hualpai mountains, and the territory in the north to Lake Mead and on down the coast to Kingman, to Wickieup and across to Flagstaff. The Glen Canyon Dam area has been covered by men working on the dam with headquarters at the Museum of Northern Arizona. Although the coverage has been wide, with many repeated trips, the list of mosses for the state will never be complete. The area is too wide and the topography too varied. There will always be more species found in Arizona.

The following abbreviations are used for the collectors of the specimens:—

B—*E. B. Bartram* M—*James A. McCleary*
C—*Rose Collom* P—*W. S. Phillips*
G—*L. N. Goodding* M.S.A.—Bartram's *Mosses of Southern Arizona*
H—*Inez M. Haring* N.A.M.P.—Grout's *North American Musci Perfecti*
L—*E. L. Little*

The nomenclature is that of Grout's *Moss Flora of North America*. The total number of mosses listed below is 400.

I wish to express my appreciation to the University of Arizona at Tucson and especially to Dr. W. S. PHILLIPS, head of the Botany Department, for laboratory space in which to work, use of equipment, transportation for the trips, and hearty co-operation extended to me, as well as the extensive collecting by Dr. Phillips and other members of the faculty; to Dr. E. B. DANSON, Director of the Museum of Northern Arizona at Flagstaff, for use of the laboratory at the Research Center and transportation for the many and often repeated trips into the northern part of the state, as well as for his own personal interest in the work; to Dr. H. C. BRYANT, former Superintendent of the Grand Canyon National Park, for laboratory space in their museum, transportation to both North and South Rims and surrounding area, and his own interest and collecting of specimens; to Mrs. U. V. PORTMANN for accompanying me on many of my trips and for her help with the manuscript; and to Mrs. HOWARD CRUM for assistance with the manuscript. To Dr. HOWARD CRUM of the National Museum of Canada in Ottawa I am more deeply indebted than I can express for the identification of many of the specimens and for his helpful suggestions without which I would not have been able to do the work. My thanks also go to the following for their assistance in determination: A. LEROY ANDREWS, E. B. BARTRAM, H. C. CONARD, SEVILLE FLOWERS, T. C. FRYE, ELVA LAWTON, and FAY MACFADDEN. Gratitude is also due to Dr. GLADYS BAKER of Vassar College for office and laboratory space.

My very great thanks are due to L. N. GOODDING, who for years has worked on the plants of Arizona and collected many, many specimens of mosses for this list. I am also indebted to the following for their collecting: WILLIAM BREED, ROY CAMERON, FRANCIS DROUET, the late HORACE HASKELL, RICHARD HEVLY, A. J. LINDSEY, T. C. MASON, W. B. MCDOUGALL, TAD NICHOLS, LOUIS SCHELLBACH, C. G. TURNER, and MILTON WETHERILL.

ANDREAEACEAE

Andreaea rupestris Hedw. Coconino Co. 11,500 ft., L-5178.

POLYTRICHACEAE

Atrichum undulatum (Hedw.) Beauv. Coconino Co. 8250 ft., H-2651, 3724.

Pogonatum alpinum (Hedw.) Röhl. Coconino Co. 10,000-11,000 ft., H-10,416; L-5168.

Polytrichadelphus lyallii Mitt. Coconino, Gila counties. 10,500-10,660 ft., C-1210; H-2840, 12,032.

Polytrichum juniperinum Hedw. Apache, Cochise, Coconino, Gila, Greenlee, Pima, Pinal, Santa Cruz counties. 6700-8350 ft., G-Cry.467; H-222, 10,577, 11,009, 11,259, 11,386.

Polytrichum piliferum Hedw. Coconino Co. 11,000 ft., H-3237; L-5104, 5119, 5164, 5169.

FISSIDENTACEAE

Fissidens adiantoides Hedw. Pima Co. 9000 ft., B-163.

Fissidens bryoides Hedw. Santa Cruz Co. 4000 ft., H-11,952, 12,200.

Fissidens cristatus Wils. Coconino, Pima counties. 8000 ft., B-3546; *Mason* 1582.

Fissidens debilis Schwaegr. Cochise, Maricopa, Pima, Santa Cruz, Yavapai counties. 2000-8000 ft., M.S.A. 11; G-Cry.164, 446; H-11,141, 11,513, 12,285, 12,362.

Fissidens exiguus var. *falcatus* (Ren. & Card.) Grout. Cochise Co. 6000 ft. H-10,623. Fo. *emarginatus* Grout. 4000 ft., *Leiberg* 805.

Fissidens garberi Lesq. & James. Cochise Co. 5000 ft., G-Cry.393, 747.

Fissidens grandifrons Brid. Glen Canyon Dam, Coconino Co. 3500 ft., H-12,445.

Fissidens limbatus Sull. Cochise, Coconino, Pima, Santa Cruz counties. 4700-8000 ft., G-Cry.76; H-3116, 3395, 11,240, 11,248, 11,599; P-2456. Var. *ensiformis* Grout. Reported by Grout in his *Moss Flora* (*J. B. Leiberg*).

Fissidens minutulus Sull. Pima Co. B-440d, 1430.

Fissidens obtusifolius Wils. Pima, Santa Cruz, Yuma counties. 2100-4000 ft., G-120; H-10,968, 11,092. Var. *apiculatus* Grout. Pima Co. 4075 ft., B-1181, 1187; H-3313, 11,143. Var. *kansanus* Ren. & Card. Santa Cruz Co. 6000 ft., B-104; H-3008.

Fissidens repandus Wils. Cochise Co. 5000-7000 ft., G-Cry.474, 476, 834; H-11,126.

Fissidens sublimbatus Grout. Cochise, Pima, Santa Cruz counties. 4015-5500 ft., G-Cry.291, 641, 642, 658, 664; H-3187, 3294, 10,811, 10,937, 11,534.

Fissidens taxifolius Hedw. Cochise Co. 6400 ft., G-Cry.198; P-2773.

Fissidens viridulus var. *texanus* (Lesq.) Grout. Coconino Co. The specimen, determined by Grout, was not returned to the University of Arizona herbarium, and further data are unavailable.

DITRICHACEAE

Bruchia brevifolia Sull. Pima Co. 3000 ft., H-3172.

Ceratodon purpureus (Hedw.) Brid. All counties. 5000-9500 ft., innumerable collections. Fo. *xanthopus* (Sull.) E.G.B. Coconino, Gila, Greenlee, Pima, Yavapai counties. 4920-8800 ft., B-3547; C-1187, 1197, 1193; H-2720.

Ceratodon stenocarpus BSG. Apache, Coconino, Cochise, Pima, Santa Cruz counties. 2000-10,000 ft., H-3413, 6004, 9040; P-3072.

Distichium capillaceum (Hedw.) BSG. Apache, Cochise, Coconino, Graham counties. 7000-11,000 ft., H-10,217, 10,943, 12,053, 12466; L-5106, 5115, 5172.

Pleuridium acuminatum Lindb. Cochise, Pima counties. 3000-5500 ft., H-3189, 12,377.

Saelania glaucescens (Hedw.) Broth. Coconino Co. 7000 ft., *Haskell* 12,044; H-11,978. New to the state.

Dicranaceae

Campylopus flexuosus (Hedw.) Brid. Pima Co. 3500 ft., H-3427.

Campylopus introflexus (Hedw.) Brid. Santa Cruz Co. 4000-6000 ft., B-576, 626, 963.

Campylopus tallulensis Sull. & Lesq. Cochise Co. 5000-6000 ft., M.S.A. 103; G-144, 256, 634; H-10,103, 10,145.

Dichodontium pellucidum (Hedw.) Schimp. Santa Cruz Co. 5000 ft., B-251.

Dicranodontium denudatum (Brid.) E.G.B. Coconino Co. 9400 ft., M-1016.

Dicranoweisia cirrhata (Hedw.) Lindb. Apache, Cochise, Coconino, Graham, Pima counties. 7600-12,000 ft., M.S.A. 5; H-3252, 10,739, 10,986, 11,842, 11,963; P-9083.

Dicranoweisia crispula (Hedw.) Lindb. Apache, Coconino counties. 9000-9575 ft., H-11,612, 11,643, 11,822, 11,864 12,532.

Dicranum bonjeanii DeNot. Santa Cruz Co. 5500 ft., B-9.

Dicranum flagellare Hedw. Santa Cruz Co. 4000 ft., H-11,415.

Dicranum montanum Hedw. Apache, Cochise, Graham, Pima, Santa Cruz counties. 5000-11,000 ft., M.S.A. 52; G-1223; H-10,190, 10,792, 10,928, 11,951; P-3055, 3075a.

Dicranum muehlenbeckii BSG (possibly). Coconino Co. 11,000 ft., L-5171.

Dicranum rhabdocarpum Sull. Apache, Cochise, Coconino, Graham, Greenlee, Pima, Santa Cruz counties. 8000-10,116 ft., G-Cry.194, 350; H-10,947, 11,416, 11,425, 11,950, 12,387; L-5171; P-2325, 3055, 3074, 3079, 9054.

Dicranum scoparium Hedw. Apache Co. 9000 ft., P-3074.

Oncophorus gracilescens (Web. & Mohr) Lindb. Apache, Pima counties. 7000-9000 ft., H-393; P-3075a.

Oncophorus polycarpus (Hedw.) Brid. Pima Co. 8500 ft., H-394.

Oncophorus wahlenbergii Brid. Pima Co. 5000 ft., H-237.

Paraleucobryum enerve (Thed.) Loeske. Coconino, Pima counties. 11,500 ft., H-11,374, 12,554; L-5105, 5163, 5177, 5178.

Paraleucobryum longifolium (Hedw.) Loeske. Cochise, Pima counties. 6000-8300 ft., B-1457; G-161, 314, 366, 521; H-11,261.

Paraleucobryum sauteri (Schimp.) Loeske. Apache, Cochise, Pima counties. 5000 ft., G-1223; H-4082, 6029, 10,612.

Symblepharis helicophylla Mont. Pima Co. 7000-8000 ft., H-389, 2351a, 9017, 11,262.

Encalyptaceae

Encalypta ciliata Hedw. Apache, Cochise, Coconino, Pima, Santa Cruz counties. 5000-8500 ft., M.S.A. 174; G-Cry.526, 537, 578; H-2456, 3107, 3815, 10,761, 11,263, 12,006; *Mason* 1582.

Encalypta rhabdocarpa Schwaegr. Apache, Coconino counties. 5500-7000 ft., H-10,923, 12,049, 12,265.

Encalypta vulgaris Hedw. Pima Co. 2000-3700 ft., H-3258, 10,377. Var. *mutica* Brid. Apache, Cochise, Coconino, Pima, Santa Cruz counties. 5000-12,000 ft., G-Cry.246, 662; H-3258, 10,426, 10,469, 10,634, 11,091, 11,265, 11,887, 12,514.

Pottiaceae

Acaulon rufescens Jaeg. Grout gives E. B. Bartram as collecting this.

Acaulon schimperianum Sull. Pima Co. 2500-7500 ft., B-115; H-2335, 3027, 11,086, 11,104, 11,267.

Aloina rigida (Schultz) Kindb. Cochise, Pima counties. 2500-6000 ft., H-11,072, 11,078, 11,088, 11,198, 11,536, 11,670.

Anoectangium arizonicum Bartr. Cochise, Pima counties. 2500 ft., G-2515; H-10,735.

Anoectangium euchloron (Schwaegr.) Mitt. Santa Cruz Co. 5000 ft., B-919, 971.

Anoectangium incurvans Bartr. Cochise Co. 6000 ft., G-Cry.248. New to U.S.A.

Anoectangium obtusifolium (Broth. & Par.) Grout. Cochise, Santa Cruz counties. 3900-6000 ft., G-Cry.378; H-3282, 10,093, 11,235.

Astomum muehlenbergianum (Sw.) Grout. Grout lists this in Arizona: no data.

Barbula acuta (Brid.) Brid. Cochise, Santa Cruz counties. 4400 ft., G-Cry.549; H-11,439, 11,472.

Barbula bescherellei Sauerb. Cochise, Coconino, Gila, Pima, Santa Cruz, Yavapai counties. 2500-9000 ft., M.S.A. 130; G-Cry. 20, 54, 115, 253, 261, 294; H-3175, 3395, 3397, 10,374, 10,818, 10,948, 11,019, 11,917.

Barbula brachyphylla Sull. Pima Co. 4500 ft., H-10,987.

Barbula cruegeri Sond. Cochise Co. 4000 ft., H-11,322.

Barbula chrenbergii (Lor.) Fl. Cochise, Coconino counties. 2500-3000 ft., *Clover & Jotter* 4195, 5291, 5298; H-11,698, 11,700, 11,701, 11,703, 11,752, 11,953.

Barbula haringae Crum. Cochise Co. 7000 ft., G-Cry.85; H-10,000.

Barbula orizabensis C.M. (forma). Santa Cruz Co. 4000 ft., H-11,984.

Barbula reflexa (Brid.) Brid. Apache Co. 5500 ft., H-12,294.

Barbula spiralis Schimp. Coconino, Pima, Santa Cruz, Maricopa counties. 1300-8000 ft., M.S.A. 56, 168; H-10,812, 11,016, 11,017, 11,408, 11,957, 12,030, 12,222.

Barbula unguiculata Hedw. Coconino, Pinal counties. 7800 ft., H-8, 11,097.

Barbula vinealis Brid. Apache, Coconino counties. 7500 ft., H-11,648, 11,711, 11,713.

Crossidium aberrans Holz. & Bartr. Cochise, Coconino, Pima, Santa Cruz counties. 1300-4000 ft., B-484 (type); H-3019, 3352, 3478, 10,913, 11,268, 11,418, 11,800.

Crossidium chloronotis (Brid.) Jur. Cochise Co. 4500 ft., *Leiberg* 1046.

Crossidium desertorum Holz. & Bartr. Apache, Cochise, Maricopa, Pima, Yuma, Yavapai counties. 1400-5000 ft., B-483; H-419, 2347, 3129, 3165, 3345, 3546a, 6020, 11,065, 12,272, 12,273.

Crossidium erosum Holz. & Bartr. Pima, Maricopa counties. 2300-7000 ft., B-120, 121; H-3087, 3343, 3344a, 3365, 11,429, 11,938, 12,289, 12,319.

Crossidium griseum (Jur.) Jur. Pima Co. 2300-2600 ft., B-65, 543; H-10,974, 11,085.

Crossidium spatulaefolium Holz. & Bartr. Mohave, Pima, Santa Cruz counties. 1600-5000 ft., B-1643; H-417, 3001, 3030, 3068, 3126, 3254, 10,978, 11,095, 11,109; *Leiberg* 1030.

Desmatodon cernuus (Hüb.) BSG. Coconino Co. 6700 ft., H-1182, 6213.

Desmatodon convolutus (Brid.) Grout. Coconino, Pima, Pinal, Yuma counties. 150-3500 ft., H-3235, 3314, 3342, 12,016; P-2648.

Desmatodon guepinii BSG. Cochise, Pima, Santa Cruz counties. 3500-5000 ft., G-Cry.382; H-3091, 3115, 3153, 3209, 11,023, 11,280, 11,525, 11,828, 11,833, 12,231.

Desmatodon latifolius (Hedw.) Brid. Cochise, Pima, Santa Cruz counties. 2500-5500 ft., M.S.A. 151; H-3153, 3209; M-711.

Desmatodon obtusifolius (Schwaegr.) Jur. Cochise, Coconino, Gila,

Maricopa counties. 2270-8288 ft., G-Cry.610; H-12,269, 12,280; *Rusby* 3a. First record in Arizona.

Desmatodon plinthobius Sull. & Lesq. Cochise, Pima, Maricopa counties. 1400-4100 ft., H-3311, 10,910, 10,911; P-2713.

Desmatodon suberectus (Hook.) Limpr. Santa Cruz Co. 4700 ft., H-3115.

Didymodon mexicanus var. *subulatus* Thér. & Bartr. Coconino, Pima counties. 2500-5000 ft., B-74; *Clover* & *Jotter* 2321a; H-3119.

Didymodon recurvirostris (Hedw.) Jenn. Apache, Cochise, Pima, Santa Cruz, Gila, Graham, Yavapai counties. 4500-9000 ft., H-3033, 10,816, 11,370, 11,682, 12,262, 12,410; P-2567. Var. *dentatus* Steere. Apache, Cochise, Pima counties. 6000-8500 ft., G-Cry.280; H-2575b, 9002, 10,977.

Didymodon rigidulus Hedw. Cochise, Santa Cruz counties. 4500-6000 ft., G-Cry.814, 49a; H-3037.

Didymodon tophaceus (Brid.) Jur. Apache, Cochise, Coconino, Maricopa, Mohave, Pima, Pinal, Santa Cruz, Yavapai counties. 3000-9500 ft., common over most of the state.

Didymodon trifarius (Hedw.) Brid. Apache, Coconino, Cochise, Pima counties. 7500 ft., *Clover* & *Jotter* 5239, 5241, 5301.

Encladium verticillatum (Brid.) BSG. Cochise, Coconino, Mohave, Yavapai counties. 3500-6500 ft., M.S.A. 23; G-Cry.19, 132, 195, 335, 527; H-10,777, 11,549, 11,590, 12,350.

Gymnostomum aeruginosum Sm. Cochise, Santa Cruz counties. 6000-6500 ft., B-840, M.S.A. 88; *Darrow* 3818; G-Cry.18; H-10,019, 11,590.

Gymnostomum calcareum Nees & Hornsch. Cochise, Pima, Santa Cruz counties. 4000-5500 ft., G-Cry.839; H-3332; P-2758.

Gymnostomum recurvirostrum Hedw. Cochise, Coconino counties. 3300-8180 ft., C-1180; G-Cry.225, 251, 286; H-10,841, 11,507, 11,696, 11,710.

Husnotiella pringlei (E.G.B.) Grout. Cochise, Coconino, Pima, Yavapai, Yuma counties. 3500-8180 ft., B-112; G-Cry.37, 288, 2515; H-10,832, 10,844, 11,562, 12,338, 12,620.

Husnotiella revoluta Card. Cochise, Pima, Santa Cruz counties. 3000-6000 ft., B-119, 1189, 1650; G-Cry.203, 557, 674; H-11,094, 11,382. Var. *palmeri* (Card.) Thér. Santa Cruz Co. 4500 ft., H-11,380.

Husnotiella torquescens (Card.) Bartr. Santa Cruz Co. 5000 ft., H-11,253, 11,472.

Hyophila tortula (Schwaegr.) Hampe. Cochise, Pima, Santa Cruz counties. 4000-6000 ft., B-100; G-Cry.199, 231, 287, 295, 558, 634, 777; H-11,441; *Leiberg*.

Merceya latifolia Kindb. Cochise Co. 8000 ft., G-Cry.63; H-11,189, 11,208.

Merceya ligulata (Spr.) Schimp. Cochise, Santa Cruz counties. 4300-7200 ft., H-10,749, 11,470, 12,367. Var. *bartramii* Bauer. Pima, Santa Cruz counties. 2500 ft., B-124; H-3450, 10,946, 11,363.

Phascum cuspidatum Hedw. Pima Co. 2400 ft., H-3150. Var. *americanum* Ren. & Card. Pima Co. 3000 ft., H-3176, 3268.

Pleurochaete squarrosa (Brid.) Lindb. Pima, Coconino counties. 2400-3400 ft., B-30, 329; *Clover* & *Jotter* 2251A, 2337, 5212B; H-11,283, 11,284, 11,741.

Pottia arizonica Wareham. Pima, Pinal, Yuma counties. 150-5500 ft., H-3224, 3257; P-2666. Common in Pima Co. Var. *mucronulata* Wareham. Cochise, Pima, Pinal counties. 1600-5800 ft., M.S.A. 985; G-Cry.539; H-3022, 3090, 3100, 3207, 3215, 3348, 11,287, 11,289, 12,378.

Pottia bryoides (Dicks.) Mitt. Pima, Santa Cruz counties. 4500 ft., B-151, 1618; H-3117.

Pterigoneurum lamellatum (Lindb.) Jur. Pima, Pinal counties. 1600-

4000 ft., N.A.M.P.473; H-3230, 3271, 3353, 3441. Many collections around Tucson.

Pterigoneurum ovatum (Hedw.) Dix. Coconino, Mohave, Pima counties. 2600-5800 ft., M.S.A.773; H-395, 421, 3023, 3026, 11,468, 11,942, 12,341.

Pterigoneurum subsessile (Brid.) Jur. Apache, Cochise, Pima counties. 2400-8000 ft., M.S.A.116; N.A.M.P.416; H-247, 260, 3010, 3087, 9041.

Rhexophyllum subnigrum (Mitt.) Thér. Santa Cruz Co. 6500 ft., B-811, 813.

Timmiella anomala (BSG) Limpr. Cochise, Pima, Santa Cruz counties. 3850-8000 ft., M.S.A.24; G-Cry.291, 469, 543; H-3451, 6058, 10,871, 11,442, 12,027.

Timmiella flexiseta (Bruch) Limpr. Pima, Santa Cruz counties. 3850-5100 ft., M.S.A.111; H-3304, 3340.

Tortella humilis (Hedw.) Jenn. Cochise Co. 5000-6000 ft., G-Cry.116, 181, 306.

Tortula aurea Bartr. Cochise, Coconino, Maricopa, Pima, Santa Cruz counties. 1500-5300 ft., M.S.A. 98, 138; *Clover* & *Jotter* 2321B; *Gould* 2914; H-6028, 10,981, 11,073, 12,116.

Tortula bartramii Steere. Cochise, Pima, Santa Cruz counties. 3120-5000 ft., M.S.A.794; H-11,361, 11,392, 11,409, 11,410, 11,521, 12,213.

Tortula bistratosa Flowers. Coconino, Mohave, Yavapai counties. 4000-8000 ft., *Flowers* 2766; H-11,694, 11,890.

Tortula brevipes (Lesq.) Broth. Pima, Yuma counties. 3000-8000 ft., H-223, 390, 3134, 3183, 3269; P-2630.

Tortula fragilis Tayl. Apache, Cochise, Navajo, Pima, Pinal, Santa Cruz counties. 2900-9500 ft., M.S.A.71, 87, 91; G-39A, Cry.241; H-3109, 3120, 3123, 3470, 4056.

Tortula inermis (Brid.) Mont. Apache, Cochise, Coconino, Gila, Maricopa, Pima, Pinal, Santa Cruz counties. 3000-8000 ft., M.S.A.10, 93; *Clover* & *Jotter* 2237A; C-1201, 1202; *Deaver* 1003; G-Cry.155, 380, 743; H-3032a, 6133, 6134, 9032, 10,908, 11,555, 12,283, 12,379; P-1212, 2717, 2737, and many others.

Tortula intermedia Brid. Cochise, Coconino, Gila, Greenlee, Maricopa, Navajo, Santa Cruz, Yavapai counties. 4000-9200 ft., G-Cry.599, 690; H-3128, 3279, 11,007, 11,008, 11,083, 12,495.

Tortula latifolia Bruch. Pima Co. 4900 ft., H-3251, 11,255, 11,530.

Tortula mucronifolia Schwaegr. Apache, Coconino counties. 8153 ft., H-6139, 9021, 11,689, 11,935, 12,132.

Tortula muralis Hedw. Pima, Santa Cruz counties. 4100 ft., H-3308, 11,178.

Tortula norvegica (Web. & Mohr) Wahl. Gila, Pima counties. 2800 ft., C-1201; H-6027, 11,292.

Tortula obtusissima (C.M.) Mitt. Apache, Cochise, Coconino, Gila, Mohave, Navajo, Pima, Santa Cruz, Yavapai counties. 2000-8000 ft., *Clover* & *Jotter* 2181A, 2321B; G-Cry.376, 385, 734; H-11,404, 11,580, 11691, 12,511; *Leiberg* 1062, and other collections.

Tortula pagorum (Milde) DeNot. Cochise, Graham, Santa Cruz counties. 8000 ft., M.S.A.15; H-11,162, 11,221, 11,224.

Tortula papillosa Wils. Apache Co. 9500 ft., H-9060. New to Arizona.

Tortula princeps DeNot. Cochise, Maricopa, Yavapai counties. 5000 ft., H-12,500; M-593, 722.

Tortula ruralis (Hedw.) Sm. Apache, Cochise, Coconino, Gila, Graham, Mohave, Navajo, Pima, Santa Cruz counties. 1400-9500 ft., collected over all the state, common.

Tortula williamsii Bartr. Santa Cruz Co. 5000 ft., M.S.A.125.

Trichostomopsis brevifolia Bartr. Pinal Co. 1600 ft. H-3234, 3255, 3317.

Trichostomopsis diaphanobasis (Card.) Grout. Cochise, Maricopa, Santa Cruz counties. 4860 ft., G-Cry.361a, 362, 674; H-11,504, 11,666a.

Trichostomum cylindricum (Bruch) C.M. Cochise, Pima counties. 5500-10,000 ft., M.S.A.49; M-681.

Weissia andrewsii Bartr. Coconino, Pima counties. 2600-6681 ft., B-1689; H-3231, 3420, 11,169; L-5158; P-3551.

Weissia glauca Bartr. Coconino Co. 8000 ft., H-11,309.

Weissia jamaicensis (Mitt.) Grout. Reported by Grout as collected by E. B. Bartram.

Weissia ligulacfolia (Bartr.) Grout. Cochise, Pima counties. 4500-6000 ft., B-1632; H-10, 163, 3108, 10,189.

Weissia tortilis (Schwaegr.) C.M. Cochise, Pima counties. 2000-8000 ft., G-Cry.200, 374, 383, 455; H-245, 3174, 3211, 3367, 11,182, 11,217, 12,230.

Weissia viridula Hedw. Cochise, Pima, Santa Cruz counties. 3000-6000 ft., M.S.A.108; C-1209; G-Cry.505; H-3035, 10,815, 10,835, 10,909, 10,919, 12,277, 12,321, and many others.

Grimmiaceae

Braunia secunda (Hook.) BSG. Cochise, Pima, Santa Cruz counties. 3500-8000 ft., B-617; G-Cry.173, 296, 573, 722; N.A.M.P.465; H-10,312, 10,533, 11,025, 11,055, 11,664.

Grimmia alpestris Nees. Coconino Co. 8000 ft., H-11,874.

Grimmia alpicola Hedw. Cochise, Coconino, Pima, Yavapai counties. 5500-8500 ft., B-17, 155, 342, 906; G-Cry.644; H-3124, 3561, 3819, 11,838, 11,874. Var. *rivularis* (Brid.) Broth. Cochise, Coconino, Pima, Santa Cruz counties. 4500-9000 ft., B-152, 331, 369, 371a; G-Cry.150, 481; H-10,724, 11,492, 11,501, 11,863, 11,875; P-2635.

Grimmia anodon BSG. Apache, Cochise, Coconino, Pinal counties. 2000-9000 ft., G-Cry.373, 384; H-3331, 12,043, 12,168, 12,264, 12,300. Fo. *anomala* (Bartr.) Jones. Coconino Co. 3750-5000 ft., B-36½, 38½, H-11,316.

Grimmia apocarpa Hedw. Apache, Coconino, Mohave, Pima, Santa Cruz, Yavapai counties. 3500-9500 ft. This species is widespread; many collections. Var. *ambigua* (Sull.) Jones. Gila Co. 4900 ft., H-3364. Var. *atrofusca* (Schimp.) Husn. Apache, Coconino, Santa Cruz counties. 4000-8500 ft., H-29, 3326, 12,010. Var. *conferta* (Funck) Spreng. Coconino Co. 5900-8350 ft., H-2756, 11,603. Var. *gracilis* (Schleich.) Web. & Mohr. Pima Co. 9000 ft., H-2583. Var. *pulvinata* (Hedw.) Jones. Coconino Co. 3300-8288 ft., H-3754, 12,003.

Grimmia arizonae Ren. & Card. Coconino, Cochise, Pima, Santa Cruz counties. 2800-8200 ft., B-75, 90; G-Cry.25, 138, 229, 249, 390; H-2341, 3416, 3754, 11,358, 11,654, 12,307. Fo. *propagulifera* Jones. Santa Cruz Co. 7000 ft., H-12,235, 12,247.

Grimmia calyptrata Hook. Cochise, Gila, Graham, Mohave, Navajo, Pima, Yavapai counties. 3000-8000 ft., C-1208; G-110, 673, Cry.719; H-3043, 11,219, 11,318, 11,650, 12,023; P-2525, 2526.

Grimmia commutata Hüb. Coconino Co. 8350 ft. B-39; H-3790.

Grimmia cribrosa Hedw. Cochise, Santa Cruz counties. 4000-6000 ft., G-Cry.617, 679, 843; H-11,028, 11,148, 11,156, 11,385, 11,401, 11,496.

Grimmia decipiens (Schultz) Lindb. Coconino, Gila, Maricopa, Mohave counties. 2100-3750 ft., G-Cry.358; H-3877, 11,048.

Grimmia doniana Sm. Pima Co. 8000-9000 ft., H-2419; P-2581c.

Grimmia dupretii Thér. Coconino Co. 8350 ft., H-3764.

Grimmia laevigata (Brid.) Brid. Coconino, Mohave, Pima counties. 2000-4000 ft., *Darrow* 3368; H-3368, 3443, 11,797, 11,979, 12,276, 12,284.

Grimmia montana BSG. Santa Cruz Co. 9400 ft., H-3407, 3412.

Grimmia orbicularis Bruch. Pima, Pinal counties. 1600-2200 ft., B-536; N.A.M.P.468; H-405, 3250, 3273.

Grimmia ovalis (Hedw.) Lindb. Apache, Cochise, Graham, Santa Cruz counties. 6500-11,500 ft., G-Cry.29, 433; H-3480, 9073, 9074, 11,582; P-2902. Fo. *mutica* Bartr. Cochise Co. 4000 ft., B-683B; G-Cry.29; M-476.

Grimmia pilifera Beauv. Cochise, Pima, Santa Cruz counties. 3500-7000 ft., G-Cry.273; H-3307, 3310, 3372, 3379.

Grimmia plagiopodia Hedw. Yavapai Co. 1100-8650 ft., H-10,865, 10,975.

Grimmia poecilostoma (Card. & Seb.) Limpr. Cochise, Pinal counties. 4500-5000 ft., B-102, 103, 104, 105, 150; G-Cry.908; H-10,734a, 11,947.

Grimmia pulvinata (Hedw.) Sm. Cochise, Coconino, Mohave, Navajo, Pima, Santa Cruz counties. 150-8200 ft. Common all over the state; many collections. Fo. *obtusa* (Brid.) BSG. Coconino Co. *MacFadden* 8047.

Grimmia rauii Aust. Apache, Coconino, Maricopa, Pima, Pinal counties. 3500 ft., H-11,589, 12,152; M-403, 406, 1034.

Grimmia trichophylla Grev. Coconino, Graham, Maricopa, Mohave, Pima counties. 3000-11,000 ft., *Clover & Jotter* 2238, 2300A, 2304, 4257; H-11,742, 11, 948, 12,339, 12,342, 12,479. Var. *muehlenbeckii* Husn. Graham, Pima counties. 4700-9000 ft., H-3125, 11,948.

Grimmia wrightii Aust. Apache, Cochise, Coconino, Maricopa, Pima, Pinal, Navajo, Santa Cruz, Yavapai counties. 2700-9400 ft., B-3; G-Cry.372, 418; H-3021, 3080, 10,857, 10,982, 11,216, 11,218, 12,348.

Hedwigia ciliata (Hedw.) Beauv. Apache, Cochise, Coconino, Pima, Santa Cruz counties. 4000-9500 ft. Common in the eastern part of the state; many collections. Fo. *leucophaea* (BSG) Jones. Cochise, Santa Cruz counties. 4000-5000 ft., G-Cry.419, 902-49; H-3283, 10,058, 11,332. Fo. *striata* (Wils.) Jones. Santa Cruz. Co. 4500 ft., G-139a. Fo. *viridis* (BSG) Jones. Cochise, Santa Cruz counties. 4500-9400 ft., H-3408, 10,299, 11,970, 11,971.

Ptychomitrium leibergii Best. Cochise, Pima, Santa Cruz, Yavapai counties. 2500-7000 ft., B-515; G-Cry.398, 590, 622; N.A.M.P.472; H-150, 3227, 3707, 10,503, 11,557, 12,249.

Rhacomitrium aciculare Brid. Cochise, Pima counties. 5000 ft., H-12,249; M-516, 520.

Rhacomitrium heterostichum (Hedw.) Brid. Gila Santa Cruz counties. 4900-5500 ft. H-148; M-320a. Var. *sudeticum* (Funck) Jones. Coconino, Gila, Santa Cruz counties. 5500 ft., H-148, 3707.

FUNARIACEAE

Entosthodon attenuatus (Dicks.) Grout. Pima Co. 4700 ft., H-3382.

Entosthodon bartramii Grout. Pima, Pinal counties. 2300 ft., B-1682, 1672, 1684; H-3095, 3381.

Entosthodon bolanderi Lesq. Coconino, Pima counties. 2500-4100 ft., B-1680; G-Cry.412, 414; H-3333, 3477, 10,906, 10,912, 11,111, 12,347; P-2712.

Entosthodon planoconvexus (Bartr.) Grout. Pima Co. 3000-5000 ft., B-1678; H-11,184.

Entosthodon rubiginosus (Williams) Grout. Pima Co. 4100 ft., M-611.

Entosthodon rubrisetus (Bartr.) Grout. Coconino, Pima, Pinal, Yuma counties, 350-5000 ft., B-1673; H-3105, 3358, 3481, 10,747, 10,922, 10,926, 11,110; P-2648a.

Entosthodon tucsonii (Bartr.) Grout. Pima Co. 3000-3500 ft., B-1679; H-3459, 3476.

Funaria hygrometrica Hedw. Cochise, Coconino, Gila, Graham, Mohave, Pima, Santa Cruz, Yavapai counties. 2200-7500 ft., cosmopolitan; throughout the state. Var. *convoluta* Hampe. Cochise, Santa Cruz counties. 4000 ft., G-Cry.689-49; H-3305. Var. *patula* BSG. Cochise, Pima, Santa Cruz counties. 5000 ft., H-3039, 10,925, 12,311. Var. *utahensis* Grout. Coconino, Gila, Mohave, Pima, Yavapai counties. 2800-5600 ft., H-3495, 3800, 4060, 6002, 12,014.

Funaria muehlenbergii Turn. Coconino, Maricopa, Pima, Yavapai counties. 1300-7218 ft., M.S.A. 117, 759; *Clover & Jotter* 2321C; H-330, 3017, 3380, 3479, 10,938, 10,942, 11,185; P-2759. Var. *lineata* Grout. Pima Co. 2000-3000 ft., N.A.M.P.474; H-3190, 3357, 3479.

Physcomitrium turbinatum (Mx.) Brid. Graham, Pima counties. 5000 ft., H-10,921, 11,375, 12,142.

Splachnaceae

Splachnobryum bernoullii C.M. Pima Co. 6500-8000 ft., B-1446a; M.S.A. 145; *Blumer* 3472.

Splachnobryum obtusum (Brid.) C.M. Pima, Pinal counties. 4000 ft., H-12,407.

Orthotrichaceae

Amphidium lapponicum (Hedw.) Schimp. Pima Co. 8000 ft., M.S.A.166; *Blumer* 3438, 3554.

Orthotrichum alpestre Hornsch. Coconino, Gila, Pima counties. 2200-7000 ft., H-4682, 5006, 11,068, 12,046, 12,343.

Orthotrichum anomalum Hedw. Coconino, Pima, Yuma counties. 350-7700 ft., L-5146, 5149; H-2437, 3873.

Orthotrichum bartramii Williams. Gila, Pima, Santa Cruz counties. 6000-7000 ft., B-27, 1465; H-392.

Orthotrichum diaphanum Brid. Gila, Graham, Pima counties. 6500 ft., H-3508, 11,131, 11,162, 11,543.

Orthotrichum hallii Sull. & Lesq. Coconino Co. 4000 ft., *Deaver* 1009.

Orthotrichum jamesianum Sull. Coconino Co. 8000 ft., H-3731.

Orthotrichum lescurii Aust. Coconino Co. 6900 ft., H-3487, 11,644.

Orthotrichum rupestre Schleich. Apache, Cochise, Pima counties. 6500-8800 ft., G-Cry.87, 468; H-391, 396, 413, 3049, 9015a, 12,260.

Orthotrichum strangulatum Schwaegr. Apache Co. 4000 ft., H-12,221.

Ulota americana (Beauv.) Limpr. Pima Co. 9000 ft., M.S.A.106.

Zygodon gracilis Wils. var. *americanus* Grout. Cochise Co. 7000 ft., G-Cry.723. (= *Leptodontium orcuttii* Bartr.; *cf.* Bryol. 54: 154-157. 1951.)

Zygodon viridissimus (Dicks.) R.Br. Collected by E. B. Bartram.

Timmiaceae

Timmia austriaca Hedw. Coconino Co. 7200 ft., H-3053.

Timmia bavarica Hessl. Apache, Cochise, Coconino, Navajo counties. 6000-9500 ft., M.S.A.127; C-1192; L-5160; H-6054, 10,771, 11,836, 11,909, 12,110; P-3033.

Timmia megapolitana Hedw. Coconino Co. 7200 ft., H-11,458.

Aulacomniaceae

Aulacomnium palustre (Hedw.) Schwaegr. Apache Co. 8800-11,500 ft., H-12,136, 12,418; P-9055, 9065, 9067.

Bartramiaceae

Anacolia laevisphaera (Tayl.) Flowers. Santa Cruz Co. 6000-6800 ft., H-3093, 3469.

Bartramia glauca Lor. Pima Co. M.S.A.1265.

Bartramia ithyphylla Brid. Coconino Co. 7000 ft., H-12,473.

Bartramia microstoma Mitt. Santa Cruz Co. 9000 ft. M.S.A.154; H-3810.

Bartramia viridissima (Brid.) Kindb. Listed in Grout's *Moss Flora* as in Arizona.

Philonotis capillaris Lindb. Santa Cruz Co. 4500 ft., B-101, 913; *Clover* & *Jotter* 2249, 2250.

Philonotis fontana (Hedw.) Brid. Apache, Cochise, Coconino, Gila, Pima, Santa Cruz counties. 3500-10,000 ft., *Darrow* 3825; G-Cry.89, 183, 765, 748; H-3262, 3263, 3437, 10,786; L-no number; P-2747, 2757, 2765, 9050. Scattered well over the state. Var. *pumila* Brid. Reported by E. B. Bartram.

Philonotis marchica (Brid.) Brid. Apache, Cochise, Santa Cruz counties. 4000-6000 ft., G-Cry.48, 153, 330, 445; H-10,044; *Mason* 1572.

Philonotis muehlenbergii (Schwaegr.) Brid. Cochise, Pima, Santa Cruz counties. 4000-7000 ft., G-Cry.332, 484; H-3275, 3306, 3325; P-2710.

Bryaceae

Brachymenium macrocarpum Card. Cochise, Gila, Pima counties. 5400-6000 ft., H-3075, 3491, 10,770.

Brachymenium mexicanum Mont. Santa Cruz Co. 4000 ft., H-479, 11,526.

Brachymenium systylium (C.M.) Jaeg. Cochise, Pima, Santa Cruz, Yavapai counties. 2700-6000 ft., G-Cry.232; N.A.M.P.393A; M.S.A.170; H-3104, 3452, 4056, 10,961, 11,379.

Bryum alpinum Brid. Apache Co. 9000 ft., P-9020.

Bryum argenteum Hedw. Throughout the state, 2300-9000 ft. Var. *lanatum* (Beauv.) BSG. Throughout the state, 2400-8000 ft.

Bryum caespiticium Hedw. Apache, Cochise, Coconino, Navajo, Pima counties. 2500-9000 ft., C-1189, 1195; G-Cry.197, 271; H-3058, 12,238.

Bryum canariense Brid. Cochise, Santa Cruz counties. 5000-7000 ft., H-12,337, 13,256.

Bryum capillare Hedw. Apache, Cochise, Coconino, Graham, Mohave, Pima counties. 3000-10,000 ft., G-Cry.180, 818; H-3151, 3330, 10,845, 12,337, 12,352; P-2495.

Bryum cirratum Hoppe & Hornsch. Coconino Co. 8000 ft., *Clover* & *Jotter* 2181C; H-14.

Bryum cuspidatum (BSG) Schimp. Cochise, Coconino counties. 4000-5400 ft., H-12,434, 12,448.

Bryum gemmiparum DeNot. Cochise, Coconino, Navajo, Pima, Santa Cruz, Yavapai counties. 4000-7000 ft., G-Cry.243, 304, 347, 10,529; H-10,550, 11,558, 11,926, 12,268, 12,326.

Bryum miniatum Lesq. Pima Co. 8000 ft., *Blumer* 3472.

Bryum muehlenbeckii BSG. Cochise, Coconino counties. 5000-6000 ft., G-Cry.220, 247; H-12,037, 12,251.

Bryum pallescens Schleich. Apache, Cochise, Coconino, Navajo, Pima, Santa Cruz counties. 4000-8500 ft., C-1198; G-Cry.751; H-3201, 3438, 4063, 10,780, 11,200, 12,195; P-2416, 2418, 2580b.

Bryum pallens (Web. & Mohr) Brid. Cochise, Coconino, Yavapai counties. 5700-7200 ft., *Darrow* 3813; Grand Canyon-57, 1962; M-375, 742.

Bryum pendulum (Hornsch.) Schimp. Grout reports it in his *Moss Flora*, no number.

Bryum pseudotriquetrum (Hedw.) Schwaegr. Apache, Cochise, Coconino, Gila, Pima, Pinal, Santa Cruz, Yavapai counties. 2700-9500 ft., *Blumer* 3461, 3558; G-Cry.101, 421, 448; H-10,741, 11,452, 11,860, 11,881; P-9069; M-321, 366.

Bryum tortifolium Funck. Cochise, Coconino, Gila, Navajo, Pima, Santa Cruz counties. 4200-8000 ft., G-Cry.46, 162, 751; H-3201, 3346, 3438, 4063.

Bryum truncorum Brid. Cochise, Pima, Santa Cruz counties. 4000-7000 ft., M.S.A.171 (as *B. comatum*); G-Cry.134, 160, 177; H-3028, 3213, 3298, 3471, 12,018, 12,353.

Bryum turbinatum (Hedw.) Schwaegr. Apache, Cochise, Gila, Pima, Santa Cruz counties. 4000-9500 ft., *Darrow* 3094; G-Cry.166; H-3122, 3415, 9014, 10,967, 11,034; P-3030, 3067. Var. *latifolium* BSG. Pima Co. 4700-5200 ft., *Gould* 3374; H-3113.

Bryum uliginosum (Brid.) BSG. Pima Co. 4500 ft., H-3059.

Bryum weigelii Spreng. Apache, Coconino counties. 9500 ft., H-11,450, 12,516; P-3067b.

Leptobryum pyriforme (Hedw.) Schimp. Apache, Coconino, Greenlee, Pima counties. 2000-8800 ft., H-2580, 3085, 11,351, 12,135, 12,529, 12,547; M-857; P-9044, 9046.

Pohlia acuminata Hoppe & Hornsch. Pima, Santa Cruz counties. 8500 ft., H-12,009; P-2461.

Pohlia cruda (Hedw.) Lindb. Apache, Coconino, Gila, Pima counties. 5500-12,655 ft., *Blumer* 3560, 3561; G-Cry.576, 865; H-2330, 3073, 12,437; L-2330, 2898, 5139, 5175, 5182; M-290.

Pohlia drummondii (C.M.) Andrews. Cochise, Pima, Santa Cruz counties. 4000-7000 ft., G-Cry.165, 426, 432, 550; H-3265; *Underhill* 3316, 3335.

Pohlia elongata Hedw. Cochise, Graham counties. 5500-9000 ft., *Blumer* 1418; G-698, 701, 716, 777; H-10,668; P-2974, 3031, 9037.

Pohlia nutans (Hedw.) Lindb. Apache, Cochise, Coconino, Graham, Greenlee, Pima counties. 5000-10,500 ft., *Darrow* 3819; G-Cry.258, 259, 263; H-11,904, 11,947; L-5130; P-2839.

Pohlia proligera Lindb. Apache, Coconino counties. 9500-10,000 ft., H-9072; L-5117.

Pohlia wahlenbergii (Web. & Mohr) Andrews. Apache, Cochise, Coconino, Gila, Greenlee, Santa Cruz, Maricopa counties. 6000-10,660 ft., G-Cry.276; H-10,828, 12,261, 12,491, 12,536; M-276, 343, 438; P-9072.

Rhodobryum roseum (BSG) Limpr. Apache, Cochise, Greenlee counties. 5000-9500 ft., H-224, 9051, 11,127; M-849, 854.

Mniaceae

Mnium affine Bland. Apache Co. 9500 ft., H-12,557; P-9091.

Mnium arizonicum Amann. Apache, Coconino, Greenlee, Pima counties. 8000-11,500 ft., B-1158; M.S.A.72 (as *M. spinulosum*); *Darrow* 305; H-11,367, 11,586, 11,716, 12,557; L-5109; *Parker* 7607; P-2915, 9061, 9068.

Mnium cuspidatum Hedw. Cochise, Coconino, Mohave, Gila, Greenlee, Pima counties. 6000-9300 ft., H-218, 2331, 9004, 11,730, 11,732; M-293, 295, 306, 846.

Mnium lycopodioides (Hook.) Schwaegr. Apache, Cochise, Coconino, Pima, Santa Cruz counties. 6000-8000 ft., G-Cry.522; H-3808, 10,783, 10,959, 12,198.

Mnium medium BSG. Graham Mt. 8000-8500 ft., H-10,715, 10,949.

Mnium serratum Brid. Cochise, Coconino, Pima counties. 5650-11,000 ft., M.S.A.37, 135; *Darrow* 3817; G-197; L-5173.

Mnium spinulosum BSG. Coconino, Pima counties. 8000-11,000 ft., *Blumer* 3559, 12,478.

Hypnaceae

Amblystegium compactum (C.M.) Aust. Apache, Cochise, Coconino, Graham, Pima, Santa Cruz counties. 3100-7500 ft., B-909; G-Cry.214; H-11,718, 11,794, 12,106; L-5134b; M-1113.

Amblystegium juratzkanum Schimp. Apache, Cochise, Coconino, Pima, Santa Cruz counties. 4100-8000 ft., *Darrow* 3815, 4814; H-3337, 10,772, 12,505, 12,577. Var. *giganteum* (Grout) Grout. Coconino Co. 8000 ft., H-3732.

Amblystegium serpens (Hedw.) BSG. Apache, Cochise, Coconino, Gila, Pima counties. 4200-9000 ft., *Darrow* 3822; G-Cry.73, 693; H-12,374; M-285; P-2329. Var. *tenue* BSG. Santa Cruz Co. 4000 ft., G-Cry.138.

Amblystegium varium (Hedw.) Lindb. Cochise, Coconino, Gila counties. 5000-6500 ft., G-Cry.196, 525; H-3813; L-5138.

Brachythecium asperrimum Mitt. Apache Co. 9500 ft., M-1097; P-9053.

Brachythecium collinum (Schleich.) BSG. Apache, Cochise, Coconino, Graham, Pima, Santa Cruz counties. 2200-10,000 ft., C-1183; G-Cry.740; H-11,369; L-5123; P-2340, 2496. Not uncommon. Var. *idahense* (Ren. & Card.) Grout. Apache, Cochise, Coconino, Pima, Gila counties. 5000-10,000 ft., G-Cry.363; H-11,058; P-9085.

Brachythecium digastrum C.M. & Kindb. Collected by E. B. Bartram.

Brachythecium erythrorrhizon BSG. Cochise, Coconino, Pima counties. 6000-10,000 ft., G-Cry.8, 57; H-9036; L-5118, 5121.

Brachythecium flagellare (Hedw.) Jenn. Apache, Cochise, Gila, Pima counties. 6000-9500 ft., G-Cry.272, 290; H-9016; P-9085. Var. *pringlei* (Williams) Grout. Reported by Grout in his *Moss Flora*.

Brachythecium lamprochryseum C.M. & Kindb. Coconino Co. (near Nevada). 8000 ft., H-12,154.

Brachythecium nelsonii Grout. Apache Co. 11,500 ft., P-9075.

Brachythecium oxycladon (Brid.) Jaeg. & Sauerb. Greenlee Co. 8100 ft., M-855.

Brachythecium petrophilum Williams. Cochise, Coconino, Santa Cruz counties. 5500-8000 ft., B-Cry.675, 688, 725; H-11,493, 11,494, 11,748.

Brachythecium rivulare BSG. Coconino, Graham, Yavapai counties. 3000-8500 ft., H-11,135, 11,824, 12,034, 12,153; M-1101.

Brachythecium rotcanum DeNot. Cochise, Graham counties. 7000-9000 ft., H-11,342, 11,964, 12,197.

Brachythecium salebrosum (Web. & Mohr) BSG. Cochise, Coconino, Gila, Graham, Santa Cruz counties. 6000-9200 ft., M.S.A.77; G-Cry.57; H-12,647; M-1101, 1103.

Brachythecium utahense James. Coconino, Gila, Mohave, Yavapai counties. 7000-9000 ft., C-1293, 13,663; H-12,280; M-348, 1029.

Campylium chrysophyllum (Brid.) Bryhn. Cochise, Coconino, Gila, Graham, Pima, Santa Cruz counties. 3500-8500 ft., B-3543; *Clover & Jotter* 5219, 5220, 5236, 5237, 5301; G-Cry.277; H-9010; L-5137; M-1107.

Camptothecium lutescens (Hedw.) BSG. Greenlee Co. 8100 ft., M-864.

Chamberlainia acuminata (Hedw.) Grout. Cochise, Coconino, Greenlee, Graham, Pima, Santa Cruz counties. 7000-9200 ft., H-12,059, 12,070, 12,427, 12,537, 12,540.

Cirriphyllum brandegei (Aust.) Grout. Pima Co. 4000 ft., H-424.

Climacium americanum Brid. Apache, Graham, Greenlee, Mohave counties. 8000-9200 ft., G-Cry.814; H-12,416, 12,481, 12,508; P-9099.

Climacium dendroides (Hedw.) Web. & Mohr. Apache Co. 9500 ft., H-9066; P-3095.

Cratoneuron filicinum (Hedw.) Roth. Apache, Cochise, Coconino counties. G-Cry.126, 547; H-10,428, 11,397, 12,257. Var. *aciculinum* (C.M. & Kindb.) Grout. Coconino Co. About 8000 ft., H-3726.

Drepanocladus aduncus (Hedw.) Warnst. Apache, Cochise, Coconino, Pima, Santa Cruz counties. 4800-9500 ft., G-Cry.49, 128, 245; H-3371, 11,512, 12,099; P-9052. Var. *polycarpus* (Bland.) Warnst. Apache Co. 7200 ft., H-12,112, 12,402.

Drepanocladus fluitans (Hedw.) Warnst. Apache, Greenlee, Yavapai counties. 7000-11,000 ft., H-12,490, 12,581; P-9095.

Drepanocladus uncinatus (Hedw.) Warnst. Coconino, Greenlee counties. 11,000 ft., H-10,451, 10,452; M-1057a.

Entodon seductrix (Hedw.) C.M. No number; collected by E. B. Bartram.

Eurhynchium diversifolium (Schleich.) BSG. Apache, Cochise, Coconino, Gila counties. 2200-8250 ft., G-Cry.367; H-415, 9015, 11,383, 12,280.

Eurhynchium fallax (Ren. & Card.) Grout. Cochise, Pima, Yavapai counties. 8000 ft., G-Cry.340; H-3072; M-228b.

Eurhynchium hians (Hedw.) Jaeg. & Sauerb. Apache, Cochise, Coconino, Santa Cruz counties. 3500-7000 ft., G-Cry.15, 16, 23; H-3197, 10,430, 10,894, 12,115; L-5141; P-2780, 2782.

Eurhynchium pulchellum (Hedw.) Jenn. Apache, Cochise, Coconino, Pima, Yavapai counties. 3000 ft., H-11,541; M-563, 828. Var. *praecox* (Hedw.) Dix. Apache, Cochise, Pima counties. 6000 ft., G-Cry.111; H-3826, 4096, 11,399.

Eurhynchium riparioides (Hedw.) Jenn. Apache, Cochise, Coconino, Graham, Santa Cruz, Yavapai counties. *Blumer* 1331; *Clover & Jotter* 2236A, 2320; G-Cry.444, 528, 535; H-3818, 10,390; M-1109, 1123; L-5141.

Eurhynchium serrulatum (Hedw.) Kindb. Coconino Co. 6000 ft. H-12,024.

Eurhynchium substrigosum Kindb. Apache Co. 5950 ft., H-12,114.

Heterophyllium haldanianum (Grev.) Kindb. Collected by E. B. Bartram.

Homomallium adnatum (Hedw.) Broth. Apache, Santa Cruz counties. 5000-7000 ft., H-243; M-900.

Homomallium mexicanum Card. Cochise, Coconino, Greenlee, Maricopa, Santa Cruz counties. 4000-6000 ft., *Blumer* 3555; H-3036, 3157, 4098, 11,894, 11,922. Var. *latifolium* Card. Cochise, Pima counties. 6000-7000 ft., G-Cry. 148, 257, 341; H-4097.

Hygroamblystegium fluviatile (Hedw.) Loeske. Coconino, Santa Cruz counties. 4000-6000 ft., H-3329; M-945.

Hygroamblystegium irriguum (Schimp.) Grout. Cochise, Coconino, Gila, Santa Cruz counties. 3500-6000 ft., G-Cry.771, 859; H-2374, 6214, 11,473. Var. *spinifolium* (Schimp.) Grout. Coconino Co. 5000-8200 ft., H-10,427, 12,068; L-5136.

Hygroamblystegium orthocladon (Beauv.) Grout. Cochise, Coconino, Gila counties. 5000-6000 ft., *Clover & Jotter* 2246, 2247, 5221; G-Cry.56, 482, 506; H-10,611, 10,776, 11,508; M-337. Fo. *brevinerve* Grout. Gila Co. 5600 ft., H-3496.

Hygrophypnum alpestre (Hedw.) Loeske. Cochise, Yavapai counties. 5300-6200 ft., M-364, 698.

Hygrohypnum dilatatum (Wils.) Loeske. Coconino Co. 5000 ft., H-12,308.

Hygrohypnum luridum (Hedw.) Jenn. Cochise, Gila counties. 6000 ft., H-12,196; M-305.

Hygrohypnum ochraceum (Turn.) Loeske. Apache, Cochise, Graham counties. 9300-11,500 ft., H-3494, 9071; M-748.

Hypnum cupressiforme Hedw. Cochise, Coconino counties. 3400-10,660 ft., H-11,611, 11,638, 11,704, 11,843; *Howell* 26,602. Var. *subjulaceum* Mol. Apache, Cochise counties. 7500 ft., H-3804, 12,552.

Hypnum imponens Hedw. Coconino Co. 8000 ft., H-11,885.

Hypnum lindbergii Mitt. Apache, Greenlee, Yavapai counties. 9000-9500 ft., H-9052, 12,503; M-843.

Hypnum reptile Mx. Pima Co. 8000-8500 ft., M.S.A.85; H-2324, 11,350.

Hypnum revolutum (Mitt.) Lindb. Apache, Cochise, Coconino, Gila, Graham, Greenlee counties. 6000-11,500 ft., G-Cry.33, 114, 364; H-10,952,

11,631, 11,633, 11,903, 11,923; L-5102, 5159, 5170, 5176, 5180; M-865a; *Parker* 7608; P-2903, 9079, 9092.

Hypnum vaucheri Lesq. Cochise Co. About 7000 ft., G-Cry.9; H-10,009.

Leptodictyum riparium (Hedw.) Warnst. Apache, Cochise, Coconino, Gila, Graham, Pima, Santa Cruz, Yavapai counties. 3000-8800 ft., G-Cry.41, 42, 238; H-3486, 4067, 10,972, 11,028; M-381; *Thornber* 5761. Var. *brachyphyllum* (Card. & Thér.) Grout. Coconino Co. 8000 ft., H-3610. Fo. *fluitans* (Lesq. & James) Grout. Yavapai Co. 5400 ft., M-1061.

Leptodictyum trichopodium (Schultz) Warnst. Santa Cruz Co. 4000 ft., H-11,868. Var. *kochii* (BSG) Broth. Apache, Cochise counties. About 7000 ft., G-Cry.43; M-829.

Plagiothecium denticulatum (Hedw.) BSG. Apache Co. 9500 ft., H-9084. Var. *aptychus* (Spr.) Grout. Graham Co. 9250 ft., M-1093.

Plagiothecium deplanatum (Sull.) Grout. Coconino, Gila, Santa Cruz counties. 4000-7300 ft., H-11,029; M-306, 774.

Plagiothecium elegans (Hook.) Sull. Collected by E. B. Bartram.

Plagiothecium geophilum (Aust.) Grout. Cochise, Santa Cruz counties. 4000 ft., G-Cry.121, 122, 653; H-11,498, 11,518, 11,520.

Plagiothecium micans (Sw.) Paris. Collected by E. B. Bartram.

Plagiothecium planissimum (Mitt.) Bartr. Santa Cruz Co. 4100 ft., H-3338.

Platygyrium fuscoluteum (Schimp.) Card. Cochise, Gila, Mohave, Pima, Pinal, Santa Cruz counties. 3000-8000 ft., N.A.M.P.497; G-Cry.169, 471; H-10,169, 10,775, 11,510, 11,973, 12,340; P-2951b; M-267b.

Pylaisia intricata (Hedw.) BSG. Cochise Co. 8000 ft., G-Cry. 111, 718.

Pylaisia polyantha (Hedw.) BSG. Cochise, Coconino counties. 6000-8000 ft., G-Cry.59, 714; H-10,278, 12,180.

Pylaisia selwynii Kindb. Cochise, Coconino, Gila, Pima, Santa Cruz counties. 5000-8000 ft., H-242, 11,346; M-261, 662, 952.

Rhytidiadelphus triquetrus (Hedw.) Warnst. Coconino Co., 5400 ft., H-12,131.

Rhytidium rugosum (Hedw.) Kindb. Cochise Co. 6400 ft., P-2772.

Scleropodium illecebrum (Hedw.) BSG. Santa Cruz Co. 4000 ft., H-3299.

Scleropodium obtusifolium (Hook.) Kindb. Gila, Pima counties. 4500-5500 ft. H-3261, 3485.

Leskeaceae

Anomodon attenuatus (Hedw.) Hüb. Apache, Cochise, Coconino, Graham, Greenlee, Pima counties. 6000-8000 ft., H-219, 220, 10,944, 11,725, 12,069, 12,487.

Anomodon minor (Beauv.) Lindb. Cochise Co. 6000 ft., G-Cry.110; H-10,768.

Anomodon rostratus (Hedw.) Schimp. Cochise, Gila, Greenlee, Navajo, Santa Cruz counties. 4000-8000 ft., G-Cry.212, 452, 490; H-3276, 4051, 10,821, 12,531; M-848.

Claopodium whippleanum (Sull.) Ren. & Card. Apache Co. 9500 ft., H-9096.

Haplohymenium triste (Ces.) Kindb. Cochise, Graham counties. 6400 ft., M-1090; P-2777.

Helodium blandowii (Web. & Mohr) Warnst. Apache Co. 9500 ft., P-9078.

Herpetineurum toccoae (Sull. & Lesq.) Card. Cochise, Santa Cruz counties. 4000-5000 ft., G-Cry.252, 255, 437; H-3297, 11,027, 11,499.

Leskea cyrtophylla Kindb. Coconino, Gila, Yavapai counties. 5000-9400 ft., M-244, 360, 963, 1019.

Leskea gracilescens Hedw. Apache Co. 9500 ft., P-9060.

Leskea nervosa (Schwaegr.) Myr. Apache, Gila, Pima counties. 8000-9300 ft., G-Cry.369; H-3070; *Parker* 7607.

Leskea tectorum (Br.) Lindb. Cochise, Coconino, Pima counties. 7500-8000 ft., H-9003, 12,028; L-5150. Var. *flagellifera* Best. Coconino Co. 7500-8300 ft., H-18, 3076, 6209; L-5148.

Leskea williamsii Best. Coconino Co. 6890 ft., M-917. Var. *filamentosa* Best. Coconino, Gila counties. 5500-8000 ft., H-3466, 3499, 11,902.

Lindbergia brachyptera (Mitt.) Kindb. Cochise Co. 8000 ft., H-11,250. Var. *austinii* (Sull.) Grout. Cochise, Yavapai counties. 9000 ft., H-11,234; M-222.

Lindbergia mexicana (Besch.) Card. Cochise Co. 8000 ft., H-11,250, in mixture.

Myurella tenerrima (Brid.) Lindb. Coconino Co. 8350 ft., H-3713.

Pseudoleskea arizonae Williams. Apache, Cochise, Coconino, Greenlee, Pima counties. 4500-9000 ft., M.S.A.35, 359, 390A; *Blumer*, in Cochise Co.; H-2574, 3078, 3210, 9018, 9038, 12,408, 12,583. (According to Lawton, this is a *Pseudoleskeella*.) Var. *papillosum* Bartr. Santa Cruz Co. 6000-6500 ft., H-3163, 3475.

Pseudoleskea atrovirens BSG. Apache, Cochise, Gila, Pima, Yavapai counties. 9500 ft., G-Cry.77; H-9096; M-352, 363, 512.

Pseudoleskea oligoclada Kindb. Coconino, Pima counties. 8000-9500 ft., M-478a, 514, 999.

Pseudoleskea radicosa (Mitt.) Lesq. & James. Coconino Co. 7500-10,250 ft., H-11,714, 11,820, 11,834, 11,867. Var. *compacta* Best. Coconino Co. 10,180 ft., H-11,826.

Pseudoleskeella catenulata var. *filescens* (Best) Lawton. Coconino Co. 7750-9550 ft., H-11,715, 11,717, 11,825, 11,927.

Pterigynandrum filiforme Hedw. Coconino Co. 7500-8000 ft., H-2370, 2372.

Rauia subcatenulata (Schimp.) Broth. Santa Cruz Co. 4000-4860 ft., H-3289, 11,502.

Thuidium abietinum (Brid.) BSG. Coconino Co. 5250-6000 ft., H-3239, 11,347, 11,722.

Thuidium angustifolium (Hampe & C.M.) Jaeg. Cochise, Pima, Santa Cruz counties. 5900-9000 ft., G-Cry.761; H-11,174, 11,202, 11,209, 11,489, 11,524.

Thuidium delicatulum (Hedw.) Mitt. Cochise, Pima counties. 4500-8000 ft., *Blumer* 3465; G-Cry. 831, 846; H-10,764.

Thuidium glaucinum (Mitt.) Dozy & Molk. (may be *T. allenii* Aust.) Pima Co. 8000 ft., *Blumer*, no number.

Thuidium microphyllum (Hedw.) Best. Cochise, Coconino, Pima, Santa Cruz counties. 4000-8000 ft., *Blumer* 3556; G-Cry.131, 198, 423, 691, 730; H-10,127, 10,145, 10,266, 10,268, 11,348. Fo. *papillosum* Grout. Cochise, Santa Cruz counties. 5000-6500 ft., H-3163, 3475, 10,781.

Thuidium virginianum (Brid.) Lindb. Gila Co. 7200 ft., M-267.

NECKERACEAE

Homalia glabella (Hedw.) Mitt. Pima Co. 5000 ft., H-324.

Neckera neomexicana (Card.) Grout. Apache Co. 9000 ft., P-9060.

Neckera pennata Hedw. Coconino, Graham, Pima counties. 8000-9000 ft., B-165; H-10,945, 12,122, 12,483. Var. *oligocarpa* (Bruch) Grout. Coconino, Pima counties. 7000-7700 ft., H-259, 12,122; L-5134; P-2331.

LEUCODONTACEAE

Leucodon brachypus Brid. Coconino, Santa Cruz counties. 4000-7000 ft., G-Cry.438; H-11, 3278.

FABRONIACEAE

Fabronia ciliaris (Brid.) Brid. Cochise, Pima, Santa Cruz counties. 5000-6000 ft., G-Cry.182; H-241, 11,139, 11,158, 11,171, 11,449, 11,471, 11,535. Var. *bartramii* Grout. Cochise, Santa Cruz counties. 4000-5000 ft., B-631; H-3334, 10,646. Var. *ovata* Grout. Cochise Co. G-Cry.643; H-11,207.

Fabronia pusilla Raddi. Santa Cruz Co. 4000-4500 ft., M.S.A.952; H-10,955, 11,446.

Fabronia ravenelii Sull. Cochise, Santa Cruz counties. 4000-8000 ft., H-11,024, 11,222, 11,490, 11,574, 11,666, 12,365.

Fabronia wrightii Sull. Cochise, Pima, Santa Cruz counties. 3000-7000 ft., M.S.A.8; G-Cry.524; H-10,373, 11,555, 11,454, 12,372. Var. *intermedia* Grout. Cochise, Santa Cruz counties. 4000-8000 ft., H-3037, 11,227, 11,388, 11,457, 11,458, 11,488.

FONTINALACEAE

Fontinalis antipyretica Hedw. Apache, Pima counties. 4750-9000 ft., H-3259, 12,553; P-9034.

Fontinalis duriaei Schimp. Santa Cruz Co. 5000-5500 ft., H-11,120.

Fontinalis novae-angliae Sull. Pima Co. 4000 ft., H-12,896.

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LICHENS OF NORTHERN SASKATCHEWAN

JOHN W. THOMSON[1] and GEORGE W. SCOTTER[2]

The junior author spent the summer field season of 1960 in the Black Lake region of northern Saskatchewan investigating the effects of fire on the winter range of the barren-ground caribou

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(*Rangifer arcticus*). This project was sponsored by the Canadian Wildlife Service of the Department of Northern Affairs and National Resources. Since lichens are thought to be important sources of winter food for barren-ground caribou, it was necessary to place special emphasis on a study of lichen succession following forest fires. The purpose of this paper is to provide a checklist of the lichens collected during this investigation.

The study area extended from 59 to 60° N. latitude and from 104 to 106° W. longitude. The lichens upon which this paper is based were collected near the darkened areas as shown on the accompanying map (*fig.* 1). No comprehensive lichen collections had been made in the area previously and the majority of the species collected represent new records for Saskatchewan, as the only previous reports from that province are a very few (Macoun, 1902; Lucy Raup, 1928, 1930). An attempt was made to collect lichens other than those thought to be important to the barren-

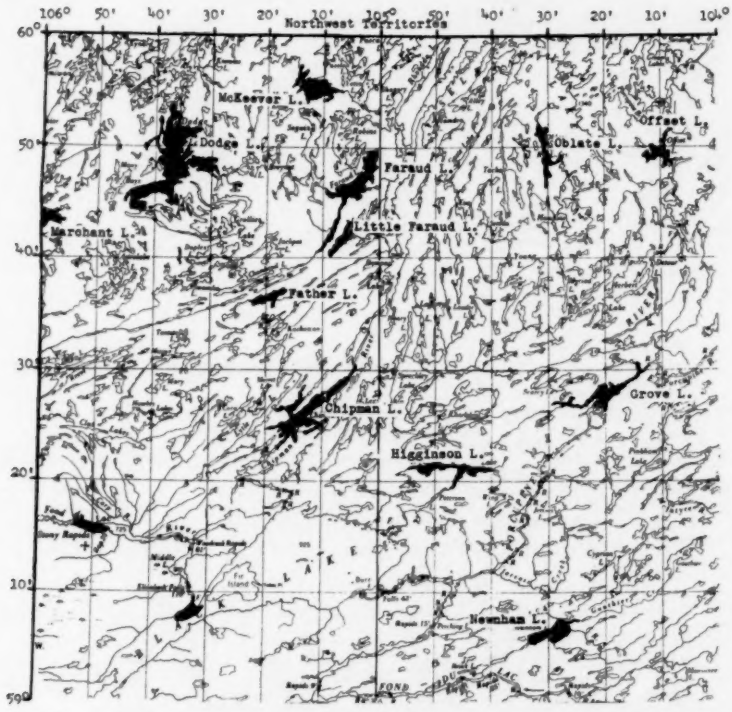

FIG. 1. The Black Lake region of northern Saskatchewan. Lichens were collected near the lakes which are darkened.

ground caribou, but a complete collection of the local microlichen flora was not made. On the other hand, all corticolous and terricolous lichens that are believed to be important food sources are represented in the collection. Some 302 samples of lichens were collected, including 102 species or 114 species, forms and varieties.

The geology of the area was described by Furnival (1941a, b). North of the Fond du Lac River–Black Lake drainage system the rocks are an old Precambrian metamorphic assemblage. The rocks are considerably folded and faulted and are variable over relatively short distances. South of this area the rock is predominantly Athabaska sandstone of a later Precambrian age. It is uniform over considerable distances and is relatively unfolded.

Little climatic data are available for the area. The climate is characterized by long cold winters and short warm summers. The average length of the frost-free period is approximately 90 days. Rainfall is light throughout the summer season.

The southern section of the region supports jack pine (*Pinus banksiana*) forests, whereas the northern section supports black spruce (*Picea mariana*) forests. White birch (*Betula papyrifera*) forests are abundant in fire-disturbed regions that formerly supported black spruce forests. A small aspen (*Populus tremuloides*) forest is present north of the Stony Rapids townsite. The vascular flora of northern Saskatchewan is known largely through the work of H. M. Raup (1936) and Scotter (1961) and through scattered collections made by Tyrrell (1897).

The set of lichens on which this article is based is deposited in the herbarium of the University of Wisconsin; a second set is being retained by the collector.

Caliciaceae

Chaenotheca chrysocephala (Turn.)T. Fr. S. Faraud L., 220. Rock outcrop, S. Newnham L., 293.

Cypheliaceae

Cyphelium tigillare Ach. Black spruce forest, on stump, N. Offset L., 127.

Pannariaceae

Pannaria pezizoides (Web.)Trev. S. Faraud L., 221.
Massalongia carnosa (Dicks.)Körb. W. Faraud L., 356.

Peltigeraceae

Nephroma arcticum (L.)Torss. Black spruce forest, NE. Higginson L., 83, 99; black spruce type, SE. Offset L., 126; NW. Chipman L., 318.

Nephroma bellum (Spr.)Tuck. Mature birch type, Faraud L., 361.

Peltigera aphthosa (L.)Willd. Black spruce type, 140 yr. old, W. Oblate L., 150; Oblate L., 191.

Peltigera canina (L.)Willd. Black L., 70; mature birch type, Faraud L., 362. Var. *rufescens* (Weis.)Mudd. On rock near camp, S. McKeever L.,

212; Stony Rapids, ½ mi. S., 245, 246. Var. *spuria* (Ach.) Schaer. Muskeg, N. Chipman L., 311. Var. *spuria* fo. *sorediata* Schaer. Muskeg burnt in 1955, E. Oblate L., 135, 136. Var. *ulorrhiza* (Flk.) Schaer. Mature birch stand, N. McKeever L., 197.

Peltigera malacea (Ach.) Funck. Black spruce type, 140 yr. old, W. Oblate L., 145; NW. Chipman L., 316.

Peltigera pulverulenta (Tayl.) Nyl. Black spruce type, NE. Higginson L., 97; NW. Chipman L., 315.

GYALECTACEAE

Microphiale diluta (Pers.) Zahlbr. On caribou antler, Black L., 326.

LECIDEACEAE

Lecidea alaiensis Vain. Father L., 341.

Lecidea assimilata Nyl. Rock outcrop, S. Newnham L., 297.

Lecidea auriculata T. Fr. Dodge L., 338.

Lecidea berengeriana (Mass.) T. Fr. Rocky cliffs, Newnham L., 304; black spruce and jack pine, mature type, Newnham L., 306.

Lecidea cuprea Sommerf. With *L. granulosa* on burn, NE. Faraud L., 224.

Lecidea granulosa (Ehrh.) Ach. Burnt area, SE. Grove L., 108; black spruce type, Offset L., 128; black spruce type, W. Faraud L., 232; 30 yr. old burn, W. Father L., 277; with *L. cuprea,* in burn, NE. Faraud L., 224.

Lecidea lapicida Ach. var. *ochracea* (Nyl.) Vain. Oblate L., 335.

Lecidea macrocarpa (DC.) T.Fr. With *Rhizocarpon obscuratum,* Offset L., 332.

Lecidea (Psora) ostreata (Hoffm.) Schaer. Black spruce type, 120 yr. old, S. McKeever L., 216; E. Offset L., 331.

Mycoblastus sanguinarius (L.) Norm. Black spruce and birch type, on birch, N. Oblate L., 183.

Rhizocarpon grande (Flk.) Arn. Higginson L., 327, 329.

Rhizocarpon lindsayanum Räs. spp. *lindsayanum* Oblate L., 334; with *Rhizocarpon grande,* Higginson L., 328.

Rhizocarpon obscuratum (Ach.) Mass. With *Lecidea macrocarpa,* Offset L., 332.

CLADONIACEAE

Baeomyces rufus (Huds.) Rebent. Oblate L., black spruce type, 174A; in birch type, 27 yr. old, E. Marchant L., 249; in burn, 30 yr. old, W. Father L., 278.

Cladonia alpestris (L.) Rabh. Black spruce type, Higginson L., 79; jack pine type, 70 yr. old, S. Grove L., 109, 122; black spruce type, S. Grove L., 113, 114; black spruce forest, 40 yr. old, W. Offset L., 131; island on E. Oblate L., 154; black spruce type, 140 yr. old, Oblate L., 155; black spruce type, SE. Oblate L., 176; black spruce and birch type, N. Oblate L., 187; Oblate L., 192; rock near camp, Oblate L., 196; rock pile, S. McKeever L., 199; 18 yr. old birch stand, N. Faraud L., 225; rock outcrop, W. Dodge L., 260, 264; NW. Chipman L., 320.

Cladonia alpicola (Flot.) Vain. Black L., 71, 349; black spruce type, W. Oblate L., 167, 173.

Cladonia amaurocraea (Flk.) Schaer. Black spruce type, NE. Higginson L., 80, 93, 101; black spruce stand, S. Grove L., 119; mature black spruce type, Faraud L., 226; birch and black spruce, 52 yr. old, S. Chipman L., 313. Fo. *celotea* Ach. Rock pile, S. McKeever L., 198. Fo. *oxyceras* (Ach.) Vain. Black spruce muskeg, W. Oblate L., 170; black spruce and birch type, N. Oblate L., 182.

Cladonia bacillaris (Ach.)Nyl. Island on E. Oblate L., 134; 18 yr. old birch stand, N. Faraud L., 219.

Cladonia botrytes (Hag.) Willd. 18 yr. old birch stand, Faraud L., 227; with *C. deformis*, Chipman L., 309.

Cladonia cariosa (Ach.)Spreng. From rock pile, Black L., 322. Var. *cribrosa* (Wallr.)Vain. Black L., 347.

Cladonia carneola Fr. Near camp, Offset L., 172; black spruce type, SE. Oblate L., 179; from tree root, mature black spruce forest, S. McKeever L., 209, 217; rock on S. corner, Faraud L., 242.

Cladonia cenotea (Ach.)Schaer. W. Father L., 280.

Cladonia coccifera (L.)Willd. N. Higginson L., 104; muskeg, N. Oblate L., 194, 195; S. Faraud L., 218; W. Faraud L., birch type, 32 yr. old, 230; ½ mi. S. Stony Rapids, 244; W. Dodge L., 273; with *C. deformis*, Chipman L., 309.

Cladonia cornuta (L.) Hoffm. Birch type, 29 yr. old, Faraud L., 177, 357; mature birch forest, SE. Faraud L., 239.

Cladonia crispata (Ach.)Flot. Black L., 343, 344, 348, 352.

Cladonia cristatella Tuck. Burn, 31 yr. old, Father L., 282. Fo. *beauvoisii* (Del.)Vain. N. Higginson L., 105.

Cladonia deformis (L.)Hoffm. Black spruce forest on island, E. Oblate L., 138, 139; mature black spruce, W. Oblate L., 163, 165; near camp, Offset Lake, 193; black spruce type, 120 yr. old, McKeever L., 202, 205, 215; mature birch forest, SE. Faraud L., 240; mature black spruce forest, Dodge L., 252; with *C. coccifera* and *C. botrytes*, Chipman L., 309, 310; near rapids, Black L., 324.

Cladonia gracilis (L.) Willd. W. Faraud L., 229. Var. *dilatata* (Hoffm.) Schaer. Black spruce type, NE. Higginson L., 81, 95; black spruce, 25 yr. old, S. Grove L., 117, 120; burn, 30 yr. old, black spruce type, W. Offset L., 130; W. Oblate L., 168; black spruce and birch type, N. Oblate L., 188; 27 yr. old birch stand, Marchant L., 248; Black L., 345. Var. *elongata* (Jacq.)E. Fr. Mature spruce forest, Grove L., NW. Bay, 121; black spruce type, SE. Oblate L., 175.

Cladonia mitis Sandst. Black spruce type, NE. Higginson L., 92, 98; jack pine type, S. Grove L., 112; rock outcrop, W. Dodge L., 263; burn, 30 yr. old, W. Father L., 275. Fo. *setigera* Sandst. Black spruce and jack pine, mature type, 120 yr. old, Newnham L., 307; NW. Chipman L., 319.

Cladonia multiformis Merr. fo. *finkii* (Vain.)Evans. ½ mi. S. Stony Rapids, 247. Fo. *subascypha* (Vain.)Evans. Pine type, 70 yr. old, S. Grove L., 125.

Cladonia pyxidata (L.)Hoffm. Rock surface, birch type N. Higginson L., 106. Var. *neglecta* (Flk.) Mass. Black spruce type, 35 yr. old, Offset L., 129. Var. *pocillum* (Ach.)Flot. Rock on south corner, Faraud L., 241.

Cladonia rangiferina (L.)Web. Black spruce island, E. shore, Higginson L., 78; mature black spruce forest, Dodge L., 253; rock outcrop, W. Dodge L., 262, 267, 269; Black L., 351.

Cladonia turgida (Ehrh.)Hoffm. W. Oblate L., 162; birch type, 20 yr. old, Faraud L., 358. Fo. *stricta* Nyl. Mature black spruce type, Chipman L., 314.

Cladonia uncialis (L.)Web. Black spruce type, NE. Higginson L., 94, 98; jack pine type, S. Grove L., 111; NE. Grove L., 115; black spruce type, S. Grove L., 118; island on E. Oblate L., 133; muskeg, E. Oblate L., 137; black spruce type, 140 yr. old, W. Oblate L., 144, 156; SE. Oblate L., 178; birch type, black spruce, N. Oblate L., 189; rock pile, S. McKeever L., 200; black spruce type, 120 yr. old, S. McKeever L., 214; mature black spruce

forest, Dodge L., 354; burn, 30 yr. old, W. Father L., 276; NW. Chipman L., 312, 317; Black Lake, 350, 353.

Cladonia verticillata (Hoffm.)Schaer. fo. *evoluta* (T.Fr.) Stein. Mature black spruce type, W. Oblate L., 171; birch type, 29 yr. old, W. Faraud L., 359, 360.

Stereocaulon alpinum Laur. Black spruce type, W. Oblate L., 140, 164.

Stereocaulon dactylophyllum Flk. Rocky outcrops, W. Dodge L., 266.

Stereocaulon paschale (L.)Hoffm. Mature black spruce, McKeever L., 203. Var. *evolutoides* (Magn.)Lamb. On rocks, E. Oblate L., 169.

Stereocaulon tomentosum Fr. Black spruce and birch type, N. Oblate L. 180; 30 yr. old birch, NW. Father L., 284.

Umbilicariaceae

Actinogyra muhlenbergii (Ach.)Schol. With *Umbilicaria hyperborea,* black spruce type, NE. Higginson L., 85; N. Oblate L., 186; rock outcrop, W. Dodge L., 261.

Lasallia papulosa (Ach.)Llano. With *Actinogyra muhlenbergii,* black spruce and birch type, N. Oblate L., 186; rock outcrop, S. Newnham L., 299.

Umbilicaria hyperborea (Ach.)Hoffm. With *Actinogyra muhlenbergii,* NE. Higginson L., 85.

Umbilicaria vellea (L.)Ach. On boulder face, W. Dodge L., 257, 258; rocky cliffs, Newnham L., 305.

Lecanoraceae

Haematomma lapponicum Räs. On rocks, S. McKeever L., 207.

Icmadophila ericetorum (L.)Zahlbr. Muskeg area, S. Higginson L., 77; black spruce type, NE. Higginson L., 100; Faraud L., 243.

Lecanora chlarona (Ach.)Nyl. With *Parmelia physodes,* black spruce type, 140 yr. old, Oblate L., 158, 159; NW. Father L., 285.

Lecanora pachythallina Lynge. S. McKeever L., 355.

Lecanora rubina (Vill.)Ach. With *Rinodina oreina,* Father L., 343.

Ochrolechia frigida (Sw.)Lynge. Rock outcrop, W. Dodge L., 268.

Ochrolechia inaequatula (Ach.)Nyl. Rocky site, McKeever L., 204.

Candelariella vitellina (Ehrh.)Müll. Arg. On rock, W. Faraud L., 231.

Parmeliaceae

Parmeliopsis ambigua (Wulf.)Nyl. N. Grove L., 82; black spruce type, 140 yr. old, W. Oblate L., 146, 147, 152; Oblate L., 190; Dodge L., 255; with *Parmelia physodes, Cetraria ciliaris, C. pinastri,* and *Alectoria jubata,* black spruce type, 140 yr. old, W. Oblate L., 153.

Parmeliopsis hyperopta (Ach.)Vain. With *Cetraria pinastri* and *Parmeliopsis ambigua,* Black L., 72.

Parmelia centrifuga (L.)Ach. On rock, Higginson L., 75; black spruce type, 140 yr. old, Oblate L., 157; mature birch type, W. Oblate L., 161; rock outcrop, S. Newnham L., 294.

Parmelia olivacea (L.)Ach. SE. bank, Higginson L., 87; black spruce and birch type, 41 yr. old, NW. Offset L., 132; black spruce type, 140 yr. old, W. Oblate L., 142; with *P. sulcata,* near camp, Faraud L., 222.

Parmelia omphalodes (L.)Ach. Rocky outcrops, W. Dodge L., 270; with *Ramalina pollinaria,* SE. bank, Higginson L., 86.

Parmelia physodes (L.)Ach. Open jack pine, Black L., 67, 73; with *Lecanora chlarona,* black spruce type, 140 yr. old, Oblate L., 153, 158; with *Cetraria ciliaris, C. pinastri,* and *Lecanora chlarona,* 31 yr. old birch stand, NW. Father L., 285.

Parmelia rudecta Ach. SE. bank, Higginson L., 88; black spruce type, 140 yr. old, W. Oblate L., 151; on rock near camp, S. McKeever L., 213.

Parmelia saxatilis (L.)Ach. On rock near camp, S. McKeever L., 211; rock outcrop, S. Newnham L., 296.

Parmelia separata T. Fr. Black spruce type, NE. Higginson L., 84; on large boulder, Father L., 289.

Parmelia sinuosa Nyl. On rock near camp, S. McKeever L., 210; with *P. rudecta*, on rock near camp, S. McKeever L., 213.

Parmelia subobscura Nyl. Rocky outcrops, W. Dodge L., 265.

Parmelia sulcata Tayl. On birch tree, Higginson L., 76; large boulder, Father L., 290; mature birch forest, SE. Faraud L., 237, 364; black spruce type, 140 yr. old, W. Oblate L., 149; on birch near camp, Faraud L., 223; with *P. olivacea*, near camp, Faraud L., 222.

Cetraria ciliaris Ach. W. Oblate L., 153; SE. Faraud L., mature birch forest, 234, 235; with *Parmeliopsis ambigua*, black spruce type, NE. Higginson L., 96.

Cetraria commixta (Nyl.)T.Fr. Boulder face, Father L., 286.

Cetraria crispa (Ach.)Nyl. Black spruce type, S.E. Higginson L., 102; jack pine forest, 70 yr. old, S. Grove L., 110; black spruce type, W. Oblate L., 166; Father L., 174B; 33 yr. old burn, Newnham L., 291; Newnham L., 308; Black L., 354.

Cetraria cucullata (Bell.)Ach. Rock outcrop, W. Dodge L., 271.

Cetraria glauca (L.)Ach. Rock outcrop, S. Newnham L., 292,295.

Cetraria hepatizon (Ach.)Vain. With *Umbilicaria hyperborea* and *Actinogyra muhlenbergii*, black spruce forest, 140 yr. old, W. Oblate L., 160.

Cetraria islandica (L.)Ach. Near rapids, Black L., 321.

Cetraria nivalis (L.)Ach. S. Grove L., 123; black spruce type, 140 yr. old, W. Oblate L., 143; black spruce and birch type, N. Oblate L., 181; mature birch type, Faraud L., 233; mature black spruce, N. Marchant L., 250.

Cetraria pinastri (Scop.) S. Gray. On granite rock, N. Higginson L., 103; 30 yr. old birch stand, NW. Father L., 283; from birch near rapids, Black L., 323; with *Parmeliopsis ambigua* and *hyperopta*, Black L., 72; with *Parmelia olivacea*, *P. sulcata*, *P. physodes*, and *Parmeliopsis ambigua*, mature birch type, Faraud L., 363; with *Parmelia physodes*, Dodge L., 256; W. Oblate L., 153.

Cetraria sepincola (Ehrh.)Ach. With *Lecanora chlarona* and *Cetraria pinastri*, black spruce type, 140 yr. old, Oblate L., 159.

Usneaceae

Alectoria jubata (L.)Ach. Open jack pine, Black L., 66; black spruce, W. Oblate L., 148, 153.

Alectoria nadvornikiana Gyel. (*A. altaica* Gyel.) Rock outcrop, W. Dodge L., 259.

Alectoria nidulifera Norrl. On rock face, N. Marchant L., 251; rocky cliffs, Newnham L., 303.

Evernia mesomorpha Nyl. Pine type, 70 yr. old, S. Grove L., 124; open jack pine, Black L., 64, 65; black spruce and birch type, on birch, N. Oblate L., 184, 185; black spruce type, NE. Higginson L., 91; large boulder, Father L., 288.

Ramalina pollinaria (Westr.) Ach. SE. bank, Higginson L., 86, 90; in shade, underside of granite rocks, S. McKeever L., 208; from rock, W. Faraud L., 228; rocky cliffs, Newnham L., 302.

Usnea dasypoga (Ach.)Röhl. W. Oblate L., 141.

Usnea hirta (L.)Wigg. Open jack pine, Black L., 68.

Usnea glabrescens (Nyl.) Vain. ssp. *glabrella* Mot. Open jack pine, Black L., 325.

CALOPLACACEAE

Caloplaca cerina (Ehrh.) T.Fr. With *C. ulmorum*, aspen tree, Grove L., 74; on aspen, Father L., 281.

Caloplaca elegans (Link.) T.Fr. SE. bank, Higginson L., 89, 330.

Caloplaca flavovirescens (Wulf.) D.T. & S. S. McKeever L., 336.

Caloplaca ulmorum (Fink) Fink. On aspen, Grove L., 74.

TELOCHISTACEAE

Xanthoria candelaria (L.) Arn. Shore of Black L., SW. corner, 69.

Xanthoria fallax (Hepp) Arn. Marchant L., 337.

BUELLIACEAE

Rinodina lecideoides (Nyl.) Vain. Mature birch forest, SE. Faraud L., 238; with *Parmelia sulcata*, mature birch forest, SE. Faraud L., 236.

Rinodina orcina (Ach.) Mass. With *Lecanora rubina*, Father L., 343.

PHYSCIACEAE

Physcia dubia (Hoffm.) Lett. Boulder face, Father L., 287.

LICHENES IMPERFECTI

Crocynia membranacea (Dicks.) Zahlbr. Mature birch type, Faraud L., 365.

Crocynia neglecta (Nyl.) Hue. Mature birch type, Faraud L., 366.

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BRYOPHYTES OF THE GALÁPAGOS ISLANDS COLLECTED PRINCIPALLY BY GUNNAR HARLING IN 1959

E. B. BARTRAM[1] AND S. ARNELL[2]

I. HEPATICAE, by S. Arnell.

A. W. Evans published a list of hepatics from the Galápagos Islands in 1902 and Lois Clark in 1953. In these lists 68 species are mentioned. I can add 13 species from the collections of Dr. Gunnar Harling in 1959. Only a few species seem to be endemic; most of the species are common to the flora of Ecuador.

**Aphanolejeunea cingens* Herz.? SANTA CRUZ: Fortuna, epiphyllous, 250 m., 5126 *p.p.*, only a few small fragments observed. AREA: Ecuador.

Aphanolejeunea sicaefolia Evs. SANTA CRUZ: Fortuna, epiphyllous, 5126 *p.p.* AREA: West Indies; Ecuador.

**Bryopteris longispica* (Spr.) St. SANTA CRUZ: Above Fortuna, 400-500 m., 5121. AREA: Andes.

Bryopteris tenuicaulis Tayl. SANTA CRUZ: Fortuna, 200 m., 5072 *p.p.* AREA: Tropical South America.

**Chiloscyphus hexagonus* Nees. SANTA CRUZ: NW. of the highest mountain top, 800 m., 5157 *p.p.*; southern mountains on dead *Scalesia pedunculata*, 800 m., 5152 *p.p.* Only a few plants, sterile. AREA: Peru.

Cheilolejeunea decidua (Spr.) Evs. SANTA CRUZ: Mountain above Fortuna, 600 m., 5082 *p.p.* AREA: Florida, West Indies, tropical South America.

**Cololejeunea cardiocarpa* (Mont.) Evs. SANTA CRUZ: Fortuna, epiphyllous, 250 m., 5126 *p.p.* AREA: West Indies.

**Colura cylindrica* Herz. SANTA CRUZ: Fortuna, 250 m., epiphyllous, rather abundant, 5126 *p.p.* AREA: Ecuador.

**Colura tenuicornis* Evs. SANTA CRUZ: Fortuna, epiphyllous, 250 m., rather sparse, 5126 *p.p.* AREA: Wide in tropical and subtropical regions.

Colura ornithocephala Herz.? SANTA CRUZ: Fortuna, epiphyllous, a few fragments, 5126 *p.p.*

Dicranolejeunea axillaris (Mont.) St. SANTA CRUZ: Southern mountains, on *Tournefortia* sp., 830 m., 5153 *p.p.* AREA: Galápagos; tropical South America.

Dendroceros crispus (Sw.) Nees. SANTA CRUZ: Mountain above Fortuna, 600 m., 5082 *p.p.* AREA: West Indies; Galápagos.

Frullania aculeata Tayl. (Syn. *Frullania mathoni* St.) SANTA CRUZ: *sine loco, F. Fagerlind & G. Wibom;* above Fortuna, 600 m., 5082 *p.p.* PINZÓN (Duncan): 350 m., 5571 *p.p.* AREA: Andes.

Frullania acuminata St. SANTA CRUZ: Southern mountains, on dead *Scalesia pedunculata*, 800 m., 5109, 5113, 5152 *p.p.*; mountain above Fortuna, 700 m., 5100. AREA: Ecuador, Peru.

Frullania brasiliensis Raddi. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 250 m., 5049. AREA: Tropical South America.

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* Species new to the islands are marked with an asterisk.

Frullania paradoxa L. & L. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 250 m., 5048 *p.p.*, 5057. AREA: Ecuador, Peru.

Frullania riojanensis (Raddi) Spr. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 250 m., 5048 *p.p.* AREA: Tropical South America.

Frullania robusta Spr. SANTA CRUZ: Mountain above Fortuna, 500 m., 5082 *p.p.* PINZÓN (Duncan): On trees, 320 m., 5573 *p.p.* and 5575. AREA: Costa Rica to Peru.

**Leptolejeunea elliptica* Spr. SANTA CRUZ: Fortuna, epiphyllous, 250 m., rather abundant, 5126 *p.p.* AREA: Tropical America.

**Lejeunea filipes* Spr. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, on *Frullania*, 250 m., 5048 *p.p.* AREA: Andes.

Leucolejeunea sp. SANTA CRUZ: NW. of the highest mountain top, only a small fragment, 5157 *p.p.*

Marchesinia galapagona (Ångstr.) St. PINZÓN (Duncan): 330 m., 5571 *p.p.* AREA: Endemic.

**Microlejeunea aphanella* Spr. PINZÓN (Duncan): 330 m., 5570 *p.p.* AREA: Tropical America.

Mylia fragilis (Jack & St.) n. comb. *Leioscyphus fragilis* Jack & St., Hedwigia 31: 20. 1892. SANTA CRUZ: Southern mountains, on dead *Scalesia pedunculata*, 800 m., only a few plants observed, 5152 *p.p.* AREA: Tropical South America.

Omphalanthus filiformis (Sw.) Nees. SANTA CRUZ: NW. of the highest mountain top, 800 m., 5157 *p.p.*, and 700 m., 5156 *p.p.*; mountain above Fortuna, 600 m., 5082 *p.p.* AREA: Tropical America.

Peltolejeunea galapagona St. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 300-400 m., 5051 *p.p.* AREA: Endemic.

**Peltolejeunea ovalis* Spr. PINZÓN (Duncan): 5570 *p.p.*, 5573 *p.p.*, typical form and *fo. obtusifolia* Spr. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 250-300 m., 5048 *p.p.*, 5051 *p.p.* SANTA CRUZ: NW. of highest mountain top, 800 m., 5157 *p.p.*; southern mountains on *Tournefortia* sp., 830 m., 5153 *p.p.* AREA: West Indies; tropical South America.

Plagiochila anderssonii Ångstr. (Syn. *P. subsimplex* St.?) SANTA CRUZ: Mountain above Fortuna, 700 m., 5100 *pp.*; Fortuna, 200 m., 5072 *p.p.* AREA: Endemic.

**Plagiochila cobana* St. SANTA CRUZ: Mountain above Fortuna, 700 m., 5100 *p.p.*; same, highest mountain top, 700 m., 5156 *p.p.*, and 800 m. 5157 *p.p.* AREA: Ecuador.

Plagiochila insularis St.? SANTA CRUZ: Fortuna, 250 m., epiphyllous, a few plants, 5126 *p.p.*; same, NW. of highest mountain top, 800 m., 5157 *p.p.* AREA: Galápagos.

Plagiochila spinifera Ångstr. SANTA CRUZ: NW. of highest mountain top, in upper *Scalesia pedunculata* forest, 800 m., 5157 *p.p.*; same, 700 m., 5156 *p.p.* AREA: Galápagos; Ecuador.

Radula sp. SANTA CRUZ: NW. of highest mountain top, 800 m., 5157 *p.p.*, only a few fragments observed.

Taxilejeunea pterogonia (L. & L.) Schiffn. SANTA CRUZ: Mountain above Fortuna, 800 m., 5082 *p.p.*; same, NW. of highest mountain top, 800 m., 5157 *p.p.*, and 700 m., 5156 *p.p.* AREA: Tropical South America.

**Prionolejeunea fabroniaefolia* Spr. SANTA CRUZ: Southern mountains on *Tournefortia* sp., 830 m., 5153 *p.p.* AREA: Ecuador, Peru.

II. Mosses, by E. B. Bartram.

Sphagnum erythrocalyx Hpe. SANTA CRUZ: *Sine loco, F. Fagerlind & G. Wibom* 2882, 2883, 2884, June 1953; mountain above Fortuna, 600 m.,

Harling 5079, May 21, 1959. AREA: Eastern United States, West Indies, British Honduras, and South America.

Sphagnum cuspidatum Ehrh. SANTA CRUZ: Mountain above Fortuna, 700 m., *Harling* 5092, May 21, 1959. AREA: Eastern United States, West Indies, Bermuda, and South America.

Campylopus flexuosus (Hedw.) Brid. PINZÓN (Duncan): On rocks, 330 m., *Harling* 5570a, June 19, 1959. AREA: Southern United States, Mexico, Central America, and Europe.

Campylopus introflexus (Hedw.) Brid. SANTA CRUZ: Mountain above Fortuna, *Harling* 5109, May 21, 1959. AREA: Wide in Europe, North America, South America, New Zealand, and Pacific Islands.

Campylopus insularis Bartr. SANTA CRUZ: Mountain above Fortuna, *Harling* 5100, May 21, 1959. AREA: Endemic.

Octoblepharum albidum Hedw. PINZÓN (Duncan): On rocks, 330 m., *Harling* 5571, June 19, 1959. AREA: Pantropical.

Syrrhopodon gaudichaudii Mont. PINZÓN (Duncan): On rocks, 330 m., *Harling* 5570, June 19, 1959. AREA: Southern United States, West Indies, Mexico, Central and South America.

**Macromitrium laevisetum* Mitt. SANTA CRUZ: NW. of highest mountain top, in upper *Scalesia pedunculata* forest, epiphyte, 700 m., *Harling* 5156, 5157, May 25, 1959. AREA: Ecuador, Brazil. New to the Galápagos Islands; this species is well known from the Ecuadorian Andes where it has been collected many times.

Papillaria nigrescens (Hedw.) Jaeg. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 250 m., *Harling* 5049a, 5047, May 17, 1959. AREA: Southern United States, West Indies, Mexico to South America, China.

Meteoriopsis patula (Hedw.) Broth. SAN CRISTÓBAL: Between Baquerizo, Moreno, and Progreso, 250 m., *Harling* 5047a, 5049, 5051, May 17, 1959. SANTA CRUZ: Fortuna, 200 m., *Harling* 5069, 5069a, 5072, May 20, 1959. AREA: Southern United States, West Indies, Mexico to South America.

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VALIDITY OF RICCIA MEDIA

K. R. BAPNA[1]

The pioneer work of K. Müller (1940, 1941) has shown that *Riccia fluitans* L., whose status was long controversial (Familler, 1920; Gaisberg, 1921; Carter, 1935), is a composite of four species, *Riccia fluitans* L. *emend.* K. M., *R. rhenana* Lorb., *R. canaliculata* Hoffm., and *R. duplex* Lorb. Since then many have followed Müller (Meijer, 1951; Schuster, 1953, Klingmüller, 1957), and there ap-

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pears to be no doubt regarding the validity of these four species. Klingmüller recently (1958) established a new species, *R. media*, based on cultural experiments. He considered *R. media* as intermediate between *R. fluitans* and *R. rhenana* and was doubtful of its occurrence in nature. The main characters taken into account to segregate *R. media* from *R. fluitans* and *R. rhenana* were width of thallus between successive dichotomies, size of air chambers, cell size, bifurcation angle, and rate of growth. Klingmüller's account clearly showed that *R. media* not only differs from *R. rhenana* in chromosome number (8) but in other aspects too. However, the similarities between *R. media* and *R. fluitans* are so great that the two seem doubtfully distinct.

The differences in size of air chambers, epidermal cells, marginal cells, and cells of ventral scales as given by Klingmüller (1958, tables 1 and 2) between *R. fluitans* and *R. media* are negligible and of little importance. They are subject to variation in the same species and even in the same individual. Furthermore, the differences regarding the width of the thalli between dichotomies and the bifurcation angle are insufficient to warrant a segregation of two forms. It is a well-known fact that environmental conditions, such as light, moisture, temperature, and nutrition, play an important part in determining the appearance and growth forms of *R. fluitans*. Also, in the Ricciaceae we often find the size and shape of thalli of an individual variable even when growing under similar conditions (some show better growth and are larger, whereas others remain small because of poor growth).

Klingmüller did not take into consideration the chromsome number which is the same in *R. fluitans* and *R. media* (8); he considered that the agreement in chromosome numbers in *R. fluitans* and *R. media* could not be decisive as all the Ricciaceae previously investigated also have only eight chromosomes. *R. media* resembles *R. fluitans* in its habit, sterility, obtuse apex, width-thickness ratio, and chromosome number.

Taking all these facts into consideration, it seems doubtful that *R. media* can be considered distinct from *R. fluitans*. The author has exchanged views on this point with Drs. S. Arnell and P. Kachroo: both are in agreement with the view expressed in this note. I am grateful to them for helpful suggestions.

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THE 1960 FORAY OF THE AMERICAN BRYOLOGICAL SOCIETY IN OKLAHOMA

JOHN W. THOMSON[1]

Despite previous warnings that Oklahoma was very warm and dry in summer and that the collecting of mosses and liverworts would be poor as a result, the foray in that state proved extremely interesting and profitable. The two days of the foray were well attended, although not by as large a group as during the past few years. There were 21 persons on the foray.

The group met on the evening of Thursday, August 25, at the Wesley Hotel in Broken Bow in the southeastern corner of Oklahoma for briefing and took advantage at the same time of the opportunity to renew friendships. A compilation of the 217 taxa of bryophytes, including 168 species of mosses and 39 species of hepatics, known from Oklahoma had been prepared by C. D. Bird and was distributed to the foray members by Dr. G. J. Ikenberry, leader of the foray.

Early the next morning the group drove to Beaver Bend State Park, McCurtain Co., where the first stop was at the youth camp. Here some of the trees were examined for corticolous species. The bryologists obtained on various substrata *Calypogeia fissa?*, *Frullania brittoniae*, *Leucolejeunea clypeata*, *Lophocolea heterophylla*, *Radula caloosiensis*, *Scapania nemorosa*, *Anomodon minor*, *Atrichum angustatum*, *Aulacomnium heterostichum*, *Bartramia pomiformis*, *Campylium chrysophyllum*, *Cirriphyllum boscii*, *Clasmatodon parvulus*, *Cryphaea glomerata*, *Ctenidium molluscum*, *Di-*

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cranum condensatum, Entodon macropus, Homomallium adnatum, Hypnum cupressiforme, Leucobryum albidum, Orthotrichum pusillum, Plagiothecium micans, Platygyrium repens, Radula obconica, and *Schwetschkeopis denticulata.* The lichenists collected *Parmelia cetrata* and *Lecanora minutella* on a Catalpa tree. The Redbuds, *Cercis canadensis,* which were ornamental on the grounds, had a considerable lichen flora on them, including *Anaptychia galactophylla, Parmelia hypotropa, Parmelia trichotera, Pyxine sorediata, Ramalina fastigiata,* and *Usnea strigosa.* A maple yielded *Caloplaca ulmorum,* and *Ulmus alata* had an abundance of Physcias, *P. ciliata, P. orbicularis, P. syncolla* and *P. tribacoides.*

After a short time at this stop the group moved to a location in the park where the stream had sharp banks beside a rock outcrop. This was a shady and moist cliff on which were numerous cryptogams. Hepatics and mosses were in abundance: *Cololejeunea biddlecomiae, Frullania squarrosa, Leucolejeunea clypeata, Porella pinnata, P. platyphylla, Radula andicola, Anomodon attenuatus, A. rostratus, A. tristis, Bartramia pomiformis, Climacium americanum, Entodon seductrix, Fissidens cristatus, F. subbasilaris, Herpetineurum toccoae* (new to Oklahoma), *Hypnum cupressiforme, H. curvifolium, Grimmia pilifera, Leucobryum glaucum, Polytrichum commune, Ptychomitrium incurvum,* and *Thelia hirtella.* The bark of hollies was conspicuously marked by map-like thalli of *Arthenopyrenia epidermidis, Anthracothecium pyrenuloides, Graphis scripta,* and *Trypethelium virens.* Especially interesting lichens collected here were *Leptogium cyanescens, Coccocarpia pellita, Parmelia crinita, Pannaria leucosticta, Sticta weigelii, Nephroma helveticum, Peltigera polydactyla, Cladonia caespiticia, C. furcata,* and *C. subcariosa.* The group worked over the rock outcrop until noon and then returned to the hotel for the luncheon which had been arranged for them.

The party met again after lunch and on the way north stopped briefly at a bog where the bryologists picked up on various substrata *Frullania brittoniae, Anomodon attenuatus, Atrichum angustatum, Aulacomnium palustre, Campylium chrysophyllum, Clasmatodon parvulus, Climacium americanum, Fissidens taxifolius, Hedwigia ciliata, Leucobryum albidum, L. glaucum, Pogonatum brachyphyllum, Polytrichum commune, Ptychomitrium incurvum, Sphagnum subsecundum, Thelia asprella, Tortella humilis,* and *Weisia viridula.* Here Herbert Sierk found an excellent colony of *Pseudocyphellaria aurata* which he shared with the other lichenologists. The caravan then continued to the game preserve 10 miles north of Broken Bow. The shale outcrop in the open sun along the stream was attacked by the hammers of the lichen collectors. Here

FIG. 1. The foray group at the game preserve near Broken Bow, Oklahoma. FRONT ROW, LEFT TO RIGHT: G. J. Ikenberry, A. J. Sharp, J. W. Thomson, and Sam Shushan. STANDING IN REAR: Robert Stratton, R. A. Anderson, Walter Ainsworth, Dennis Knight, K. G. Foote, H. A. Sierk, Jan Looman, Darvin Keck, and H. H. Holliger.—Also on the foray but not in the photograph were R. A. Darrow and Mrs. Darrow, W. A. Weber, Fred Sharp, Mrs. Holliger, John Holliger, Steffann Holliger, and Mrs. Ainsworth. (*Photograph by H. H. Holliger.*)

were excellent specimens of *Physcia frostii, Lecidea albocaerulescens, Buellia stigmaea,* and *Rinodina bischoffii.* On a red cedar on the shale was the excellent find, *Leptogium marginellum.* In the bed of the stream exposed rocks bore *Lecanora lacustris.* Along the old roadway through the woods were abundant colonies of *Cladonia furcata, C. subtenuis, C. chlorophaea,* and *C. subcariosa.* At the base of a few trees were small thalli of *Pseudocyphellaria,* and on some of the fallen branches, indicating an unreachable flora in the upper parts of the trees, were *Coccocarpia parmelioides.* The bark of some of the trees had *Leptogium corticola* on them, and one old stump had *Collema conglomeratum.* Collecting continued as long as possible, and then the foray members adjourned to the hotel. Some of the members took advantage in the late evening of a cake and coffee sale at the hotel.

On Saturday, August 27, the members of the foray drove during the morning toward the more arid part of Oklahoma, noting

the rapid changes in the vegetation from the moist forests of the southeastern corner of the state. By noon they had arrived at Platt National Park near Sulphur. A short stop at the springs enabled them to stretch their legs before adjourning to the hotel at Sulphur for lunch. This fortification enabled them to attack the rock formations near Turner Falls, Murray Co., where the clanking of hammers soon resounded in all directions. The limestone rocks yielded *Verrucaria fuscella, Endocarpon pusillum, Porocyphus furfurellus, Pyrenopsis polycocca, Rhizocarpon posthumum, Acarospora strigata, A. glaucocarpa, Haematomma subpuniceum,* and *Buellia thomae.* On the soil was an abundance of *Dermatocarpon hepaticum.* The bryologists here obtained great quantities of *Pleurochaete squarrosa.*

After working the open limestone area near the falls, the group moved on to Turner Falls, where some worked below the falls, some above. At the top of the falls were many of the same lichens as on the limestone outcrops already examined. *Verrucaria calciseda* and *Lecidea russelli* were added to the list of lichens, and a rare find, *Speerschneidera euploca,* was picked up in small amounts by Jan Looman on mossy rocks in the stream bed at the head of the falls. As the afternoon was by now waning, the foray disbanded and drove northward to Stillwater. Here they were the guests of Dr. and Mrs. Gilford J. Ikenberry at a delightful supper of chicken and watermelon and many other delicious dishes. The group was joined by W. C. Steere and E. L. Little. Properly surfeited, the forayers rested in the cool of the evening in the backyard and watched two transits of the satellite Echo. The members of the foray group appreciated very much the arrangements and the generous hospitality of the Ikenberrys.

I am much indebted to Dr. A. J. Sharp, University of Tennessee, for help with the list of mosses and liverworts observed on the foray.

LICHENS COLLECTED IN OKLAHOMA AT THE TIME OF THE AMERICAN BRYOLOGICAL SOCIETY MEETINGS

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At the time of the meetings of the American Bryological Society in Stillwater, Oklahoma, the foray which started in Broken

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Bow yielded such an excellent list of lichens new to the state that this list was prepared for publication with the foray report. I am much indebted to Jan Looman of the University of Wisconsin and Herbert A. Sierk of MacMurray College, Jacksonville, Illinois, for records which make the list more complete.

The foray report briefly describes the localities in which most of the collecting was done. Immediately following the foray, on Sunday, August 28, some of the lichenologists were led by Dr. Henry I. Featherly to a prairie a short distance west of Stillwater where they collected on soil, rocks, and oaks. During the AIBS sessions, Jan Looman made one trip to the Glass Mountains in Major County, where he collected an additional series of lichens. The best find here was *Acarospora reagens* on soil, far east of its original report in California. Another short trip north of Stillwater yielded a few additional species. There have been only two previous reports on Oklahoma lichens, those by Joyce Hedrick (1931) and Mason E. Hale (1957). The largest part of the collections made during the foray and meetings represent new records for the state. A set of specimens is deposited in the herbarium of the University of Wisconsin.

VERRUCARIACEAE

**Verrucaria calciseda* Lam. & DC. On limestone above Turner Falls, Arbuckle Mts., Murray Co., 8685, 8923.

**Verrucaria fuscella* E. Fr. On limestone, Arbuckle Mts. near Turner Falls, 8678.

DERMATOCARPACEAE

**Dermatocarpon aquaticum* (Weis.) Zahl. On rocks near water, Beaver Bend State Park, McCurtain Co., 6585, 6588.

**Dermatocarpon hepaticum* (Ach.) T. Fr. On soil among rocks near junction of highways 15 and 40, 15 mi. S. of Ponca City, Noble Co., 8927, 8931; on soil, Turner Falls, Arbuckle Mts., Murray Co., 8675, 8930; on soil in crevices in rocks, above Turner Falls, Arbuckle Mts., Murray Co., 8928; on soil in a prairie, 6 mi. W. of Stillwater, Payne Co., 8952; on soil, Glass Mts., W. of Orienta, Major Co., *J. Looman*.

**Dermatocarpon miniatum* (L.) Mann. Over moist, shaded rock face, conglomerate, Platt National Park, Murray Co., 8950.

Dermatocarpon tuckermanii (Rav.) Zahl. On base of oak, Beaver Bend State Park, McCurtain Co., 6579.

**Endocarpon pusillum* Hedw. On limestone, Arbuckle Mts., Turner Falls, Murray Co., 8676; on limestone, Glass Mts., W. of Orienta, Major Co., *J. Looman*.

PYRENULACEAE

**Arthopyrenia epidermidis* (DC.) Mass. On *Ilex*, Beaver Bend State Park, McCurtain Co., 8614.

**Anthracothecium pyrenuloides* (Mont.) Müll. Arg. On *Ilex*, Beaver Bend State Park, McCurtain Co., 8619.

* Records new to the state of Oklahoma.

TRYPETHELIACEAE

**Trypethelium virens* Tuck. On *Ilex*, Beaver Bend State Park, McCurtain Co., 8617; on red oak, Beaver Bend State Park, McCurtain Co., 8610.

CALICIACEAE

**Mycocalicium polyporeum* (Nyl.) Vain. On *Polystictus*, Game Preserve N. of Broken Bow, McCurtain Co., 6575.

GRAPHIDACEAE

**Graphis intricata* Fée. On red oak, Beaver Bend State Park, McCurtain Co., 8612.

**Graphis scripta* (L.) Ach. On *Ulmus alata*, Beaver Bend State Park, McCurtain Co., 8620; on *Ilex*, Beaver Bend State Park, McCurtain Co., 8615.

DIPLOSCHISTACEAE

**Diploschistes actinostomus* (Pers.) Zahl. On sandstone in prairie, 6 mi. W. of Stillwater, Payne Co., 8954.

Diploschistes scruposus (Schreb.) Norm. On soil, Glass Mts., W. of Orienta, Major Co., *J. Looman*.

EPHEBACEAE

**Ephebe lanata* (L.) Vain. On rock in open, Beaver Bend State Park, McCurtain Co., 8631.

**Porocyphus furfurellus* (Nyl.) Forss. On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8684.

PYRENOPSIDACEAE

**Psorotichia schaereri* (Mass.) Arn. On limestone above Turner Falls, Arbuckle Mts., Murray Co., 8926.

**Pyrenopsis polycocca* (Nyl.) Tuck. On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8677.

COLLEMACEAE

Collema conglomeratum Hoffm. var. *crassiusculum* (Malme) Degel. At base of dead tree stub, Game Preserve N. of Broken Bow, McCurtain Co., 8602.

**Collema crispum* (Huds.) G. H. Web. On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8681.

**Collema tenax* (Sw.) Ach. *em.* Degel. Over moist, shaded rock face conglomerate. Platt National Park, Murray Co., 8948; on soil in eroded area, 15 mi. S. of Ponca City, Noble Co., 8943; on soil, Glass Mts., W. of Orienta, Major Co., *J. Looman*.

**Collema tunaeforme* (Ach.) Ach. *em.* Degel. In crevice between rocks, 15 mi. S. of Ponca City, Noble Co., 8946.

**Lempholemma umbella* (Tuck.) Zahl. On limestone, above Turner Falls, Arbuckle Mts., Murray Co., 8922.

**Leptogium chloromelum* (Sw.) Nyl. On oak, 20 mi. N. of Broken Bow, McCurtain Co., *H. A. Sierk* 1118.

Leptogium corticola (Tayl.) Tuck. On *Ulmus alata*, Game Preserve N. of Broken Bow, McCurtain Co., 6572; on dead stub, Game Preserve N. of Broken Bow, McCurtain Co., 6574.

Leptogium cyanescens (Ach.) Körb. On soil over rocks, Beaver Bend State Park, McCurtain Co., 6581.

**Leptogium juniperinum* Tuck. On rock, Beaver Bend State Park, McCurtain, *H. A. Sierk* 1142.

**Leptogium marginellum* (Sw.) S. F. Gray. On red cedar in area of dam, Game Preserve N. of Broken Bow, McCurtain Co., 8655.

Leptogium saturninum (Dicks.) Nyl. On soil over rock, Beaver Bend State Park, McCurtain Co., *H. A. Sierk* 1141.

Heppiaceae

**Heppia polyspora* Tuck. On soil, Glass Mts., W. of Orienta, Major Co., *J. Looman.*

Pannariaceae

Coccocarpia parmelioides (Hook.) Trev. On fallen branch, Game Preserve N. of Broken Bow, McCurtain Co., 6560.

**Coccocarpia pellita* (Ach.) Müll. Arg. On soil over rock, Beaver Bend State Park, McCurtain Co., 6558.

Pannaria leucosticta Tuck. On rocks in shade, Beaver Bend State Park, McCurtain Co., 8630; on shale, Beaver Bend State Park, McCurtain Co., 8641; on rock, Beaver Bend State Park, McCurtain Co., 6582; on dead stub, Game Preserve, N. of Broken Bow, McCurtain Co., 6559.

Pannaria pityrea (DC.) Degel. At base of an oak tree, Beaver Bend State Park, McCurtain Co., 8596.

**Placynthium nigrum* (Huds.) S. F. Gray. On calcareous rocks on ridge 15 mi. S. of Ponca City, Noble Co., 8958.

Stictaceae

Pseudocyphellaria aurata (Ach.) Vain. At base of *Carya*, Game Preserve N. of Broken Bow, McCurtain Co., 6571; at base of oak, Game Preserve N. of Broken Bow, McCurtain Co., 6570; on base of tree, 10 mi. N. of Broken Bow, McCurtain Co., 8674.

**Sticta weigelii* (Ach.) Vain. On shaded rock outcrop, Beaver Bend State Park, McCurtain Co., 6583.

Peltigeraceae

Nephroma helveticum Ach. On rocks, Beaver Bend State Park, McCurtain Co., 6578, 8591, 8662.

Peltigera canina (L.) Willd. On humus on rock, Beaver Bend State Park, McCurtain Co., *H. A. Sierk* 1180.

Peltigera polydactyla (Neck.) Hoffm. On soil over rock, Beaver Bend State Park, McCurtain Co., 6566.

Lecideaceae

**Bacidia granosa* (Tuck.) Fink. Over moist, shaded rock face, conglomerate, Platt National Park, Murray Co., 8949.

Bacidia schweinitzii Tuck. On red oak, Beaver Bend State Park, McCurtain Co., 8608.

**Bacidia suffusa* (E. Fr.) Schneid. On ash, Beaver Bend State Park, McCurtain Co., 8606.

**Lecidea albocaerulescens* (Wulf.) Mass. On rocks in stream, Beaver Bend State Park, McCurtain Co., 8668; on shale by dam, Game Preserve N. of Broken Bow, McCurtain Co., 8643.

Lecidea decipiens (Ehrh.) Ach. On soil with *Dermatocarpon hepaticum*, 15 mi. S. of Ponca, Noble Co., 8953; on soil, Glass Mts., W. of Orienta, Major Co., *J. Looman.*

Lecidea icterica (Mont.) Tayl. On soil in prairie on sandstone outcrop, 6 mi. W. of Stillwater, Payne Co., 8929.

**Lecidea lucida* Ach. On shaded rock face, Beaver Bend State Park, McCurtain Co., 8671.

Lecidea russellii Tuck. On limestone above Turner Falls, Arbuckle Mts., Murray Co., 8925.

**Rhizocarpon posthumum* (Nyl.) T. Fr. On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8683.

Cladoniaceae

**Cladonia bacillaris* (Ach.) Nyl. On rotten log, Beaver Bend State Park, McCurtain Co., 6561, 8595.

**Cladonia caespiticia* (Pers.) Flk. On soil on rock face, Beaver Bend State Park, McCurtain Co., 6580.

**Cladonia capitata* (Mx.) Spreng. fo. *imbricatula* (Nyl.) Evans. On soil mound, Beaver Bend State Park, McCurtain Co., 6563.* Fo. *microcarpa* (Evans) Evans. On soil at edge of prairie, 10 mi. S. of Ponca City, Noble Co., 8945.

Cladonia chlorophaea (Flk.) Spreng. Fo. *simplex* (Ach.) Harm. On soil, Beaver Bend State Park, McCurtain Co., 8664.

**Cladonia clavulifera* Vain. On pine stump, Beaver Bend State Park, McCurtain Co., *H. A. Sierk* 1204.

Cladonia furcata (Huds.) Schrad. var. *pinnata* (Flk.) Vain. fo. *foliolosa* (Del.) Vain. On soil, Game Preserve N. of Broken Bow, McCurtain Co., 8593; on soil, Beaver Bend State Park, McCurtain Co., 8672.

**Cladonia grayi* Merr. On rotten log in open, Beaver Bend State Park, McCurtain Co., 8601.

**Cladonia subcariosa* Nyl. On soil at edge of old road, Game Preserve N. of Broken Bow, McCurtain Co., 8597; on soil over rocks, Beaver Bend State Park, McCurtain Co., 8592; on soil in open with *C. subtenuis*, Beaver Bend State Park, McCurtain Co., 6587; along the line of an old log on soil, Game Preserve N. of Broken Bow, McCurtain Co., 6589; on soil mound, Beaver Bend State Park, McCurtain Co., 6568.

**Cladonia subtenuis* (des Abb.) Evans. On earth bank at edge of road, Game Preserve N. of Broken Bow, McCurtain Co., 8598; on soil in open, Beaver Bend State Park, McCurtain Co., 6586.

Acarosporaceae

**Acarospora bella* (Nyl.) Jatta. On sandstone in prairie 6 mi. W. of Stillwater, Payne Co., 8957.

**Acarospora glaucocarpa* (Wg.) Körb. On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8686.

**Acarospora oceliata* Magn. On sandstone in prairie 6 mi. W. of Stillwater, Payne Co., 8955.

**Acarospora reagens* Zahl. On soil, Glass Mts., near Orienta, Major Co., *J. Looman*. A major range extension from the original locality in California.

**Acarospora strigata* (Nyl.) Jatta. On limestone pebbles in eroded area, 15 mi. S. of Ponca City, Noble Co., 8942.

Pertusariaceae

**Pertusaria laevigata* (Nyl.) Arn. On red maple, Game Preserve N. of Broken Bow, McCurtain Co., 8621.

**Pertusaria leioplaca* (Ach.) Lam. & DC. On ash, Beaver Bend State Park, McCurtain Co., 8605.

Pertusaria multipuncta (Turn.) Nyl. On *Carya*, Beaver Bend State Park, McCurtain Co., 8637.

**Pertusaria plitteana* Erichs. On shale by dam, Game Preserve N. of Broken Bow, McCurtain Co., 8642.

**Pertusaria pustulata* (Ach.) Duby. On *Carya*, Beaver Bend State Park, McCurtain Co., 8638.

**Pertusaria tuckermanii* Erichs. On red maple, Game Preserve N. of Broken Bow, McCurtain Co., 8622.

**Pertusaria velata* (Turn.) Nyl. On *Carya*, Beaver Bend State Park, McCurtain Co., 8654.

Pertusaria (probably *wulfenii* but lacking spores). On red oak, Beaver Bend State Park, McCurtain Co., 8609.

LECANORACEAE

**Candelariella dispersa* (Räs.) Hakul. On rocks in pasture, 6 mi. W. of Stillwater, Payne Co., 8937.

**Haematomma subpuniceum* B. de Lesd. On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8679.

**Lecanora badia* (Hoffm.) Mass. On rocks in pasture, 6 mi. W. of Stillwater, Payne Co., 8940.

**Lecanora contorta* (Hoffm.) Stein. On limestone, 15 mi. S. of Ponca City, Noble Co., 8934.

**Lecanora lacustris* (With.) T. Fr. On rocks in stream bed by dam, Game Preserve N. of Broken Bow, McCurtain Co., 8645, 8666.

**Lecanora minutella* Nyl. On *Catalpa*, Beaver Bend State Park, McCurtain Co., 8634.

Lecanora muralis (Schreb.) Rabh. On rocks in pasture, 6 mi. W. of Stillwater, Payne Co., 8936.

Lecanora pallida (Schreb.) Rabh. On red oak, Beaver Bend State Park, McCurtain Co., 8613.

**Lecanora pruinosa* Chaub. On calcareous sandstone, N. of crossing of highways 15 & 40, 15 mi. S. of Ponca City, Noble Co., 8947.

**Lecanora subfuscata* Magn. On red maple, Game Preserve N. of Broken Bow, McCurtain Co., 8624.

Candelaria concolor (Dicks.) Arn. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8966; on *Ulmus alata*, Beaver Bend State Park, McCurtain Co., 8529.

Parmelia aurulenta Tuck. On ash, Beaver Bend State Park, McCurtain Co., 8603.

Parmelia bolliana Müll. Arg. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8963.

Parmelia caperata (L.) Ach. On dead tree, 20 mi. N. of Broken Bow, McCurtain Co., *H. A. Sierk* 1126.

Parmelia caroliniana Nyl. On pine, 20 mi. N. of Broken Bow, McCurtain Co., *H. A. Sierk* 1100.

Parmelia cetrata Ach. On *Carya*, Beaver Bend State Park, McCurtain Co., 6584.

Parmelia conspersa (Ehrh.) Ach. On rock, Beaver Bend State Park, McCurtain Co., *H. A. Sierk* 1218.

Parmelia crinita Ach. On boulders in shade, Beaver Bend State Park, McCurtain Co., 6590.

Parmelia erecta Berry. On dead tree, 20 mi. N. of Broken Bow, McCurtain Co., *H. A. Sierk* 1128.

**Parmelia hypotropa* Nyl. On *Cercis*, Beaver Bend State, Park, McCurtain Co., 8647.

Parmelia hypotropoides Nyl. On *Quercus,* Game Preserve N. of Broken Bow, McCurtain Co., 8650.

Parmelia rudecta Ach. On *Quercus,* Game Preserve N. of Broken Bow, McCurtain Co., 8651.

Parmelia subcrinita Nyl. On rock outcrop, Beaver Bend State Park, McCurtain Co., *H. A. Sierk* 1186.

Parmelia subquercifolia Hue. On hickory, 20 mi. N. of Broken Bow, McCurtain Co., *H. A. Sierk* 1101.

**Parmelia trichotera* Hue *em.* DR. On *Cercis,* Beaver Bend State Park, McCurtain Co., 6569.

Usneaceae

Ramalina fastigiata (Pers.) Ach. On *Cercis,* Beaver Bend State Park, McCurtain Co., 6564.

Usnea rubicunda Stirt. On oak, Game Preserve, N. of Broken Bow, McCurtain Co., 6573.

Usnea strigosa (Ach.) Eaton. On *Cercis,* Beaver Bend State Park, McCurtain Co., 6567, 8646.

Usnea trichodea Ach. *em.* Mot. On post oak, W. gate of Game Preserve N. of Broken Bow, McCurtain Co., 8932.

Caloplacaceae

**Fulgensia fulgens* (Sw.) Elenk. On soil, Glass Mts., W. of Orienta, Major Co., *J. Looman.*

**Protoblastenia rupestris* (Scop.) Zahl. Over moist, shaded rock face, conglomerate, Platt National Park, Murray Co., 8951.

Caloplaca aurantiaca (Lightf.) T. Fr. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8961.

Caloplaca camptidia (Tuck.) Zahl. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8960.

**Caloplaca flavovirescens* Arn. On limestone rocks, 15 mi. S. of Ponca City, Noble Co., 8933, 8944, 8948; on rocks in pasture, 6 mi. W. of Stillwater, Payne Co., 8939.

**Caloplaca microphyllina* (Tuck.) Hasse. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8969; on elm, Platt National Park, Murray Co., 8672.

Caloplaca sideritis (Tuck.) Zahl. On rocks in pasture, 6 mi. W. of Stillwater, Payne Co., 8941.

**Caloplaca ulmorum* (Fink) Fink. On *Acer,* Beaver Bend State Park, McCurtain Co., 8649.

Teloschistaceae

Teloschistes chrysopthalmus (L.) T. Fr. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8968.

**Xanthoria fallax* (Hepp) Arn. *On Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8967.

Speerschneidera euploca (Tuck.) Trev. On mossy rocks by stream at head of Turner Falls, Murray Co., *J. Looman.*

Buelliaceae

**Buellia parasema* (Ach.) DeNot. var. *triphragmia* (Nyl.) T. Fr. On red maple, Game Preserve N. of Broken Bow, McCurtain Co., 8623.

**Buellia punctata* (Hoffm.) Mass. On rocks in pasture 6 mi. W. of Stillwater, Payne Co., 8935.

Buellia spuria (Schaer.) Anzi. On rocks in stream, Beaver Bend State Park, McCurtain Co., 8667.

**Buellia stigmaea* Tuck. On shale rocks near dam, Game Preserve N. of Broken Bow, McCurtain Co., 8632.

**Buellia stillingiana* Stein. On red oak, Beaver Bend State Park, McCurtain Co., 8611.

**Buellia thomae* (Tuck.) Imsh. On limestone above Turner Falls, Arbuckle Mts., Murray Co., 8924.

**Rinodina applanata* Magn.? On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8960.

**Rinodina bischoffii* (Hepp) Mass. On rocks in stream bed by dam, Game Preserve N. of Broken Bow, McCurtain Co., 8665.

**Rinodina destitula* (Nyl.) Zahl.? On limestone, Arbuckle Mts. near Turner Falls, Murray Co., 8680.

**Rinodina ocellata* (Hoffm.) Arn. On sandstone in prairie, 6 mi. W. of Stillwater, Payne Co., 8956.

**Rinodina tephraspis* (Tuck.) Herre. With *Buellia spuria* & *Lecidea albocaerulescens*, on rocks in stream, Beaver Bend State Park, McCurtain Co., 8670.

PHYSCIACEAE

Anaptychia galactophylla Trev. On *Cercis*, Beaver Bend State Park, McCurtain Co., 6565; on elm, Beaver Bend State Park, McCurtain Co., 8594; on *Robinia*, Beaver Bend State Park, McCurtain Co., 8651; on red cedar, Beaver Bend State Park, McCurtain Co., 8663.

Anaptychia speciosa (Wulf.) Mass. On ash, Beaver Bend State Park, McCurtain Co., 8607; on rock face, Beaver Bend State Park, McCurtain Co., 6562

Physcia aipolia (Hoffm.) Hampe. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8965.

**Physcia albicans* (Pers.) Thoms. On *Robinia*, Beaver Bend State Park, McCurtain Co., 8644.

Physcia ciliata (Hoffm.) DR. On *Ulmus alata*, Beaver Bend State Park, McCurtain Co., 8528. *Fo. *fibrillosa* Thoms. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8964.

**Physcia frostii* Tuck. On rocks in area of dam, Game Preserve N. of Broken Bow, McCurtain Co., 8661.

Physcia orbicularis (Neck.) Poetsch. On *Ulmus alata*, Beaver Bend State Park, McCurtain Co., 8527. *Fo. *albociliata* (Tuck.) Thoms. On *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8961. *Fo. *rubropulchra Degel.* On ash, Beaver Bend State Park, McCurtain Co., 8604.

Physcia syncolla Tuck. On *Ulmus alata*, Beaver Bend State Park, McCurtain Co., 8525; on *Quercus stellata* in prairie, 6 mi. W. of Stillwater, Payne Co., 8962; on elm, Platt National Park, Murray Co., 8675; on *Robinia*, Beaver Bend State Park, McCurtain Co., 8653.

Physcia tribacoides Nyl. On *Ulmus alata*, Beaver Bend State Park, McCurtain Co., 8526; on *Robinia*, Beaver Bend State Park, McCurtain Co., 8652.

Pyxine sorediata (Ach.) Mont. On *Cercis*, Beaver Bend State Park, McCurtain Co., 8648; on *Carya*, Beaver Bend State Park, McCurtain Co. 8636.

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THE DISCOVERY OF MERCEYA IN ILLINOIS

G. NEVILLE JONES[1]

The occurrence of certain bryophytes on substrata containing copper or other heavy metals has been observed and studied by several bryologists. The more or less constant occurrence of these rare bryophytes on metallic rocks has directed attention to ore deposits. The literature of "copper mosses" has been reviewed by Persson (1948). Schatz (1955, p. 113) has presented a "biogeochemical explanation for the unusual substrate preference and edaphic relationships of the cuprophilic bryophytes."

The small genus *Merceya* is one of the so-called "copper mosses," The first collection in Illinois of *Merceya ligulata* (Spruce) Schimp. was made in the northern part of the state in 1952 by the veteran Illinois botanist, Dr. V. H. Chase, who has made several important discoveries of plants in Illinois and elsewhere.

Not only is this a rare plant in North America, but as Grout (1939, p. 246) says, the systematic position of the genus *Merceya* has not been well established because the sporophyte is seldom observed. "The structure of the stem and leaves relates it to both Tortulaceae and Encalyptaceae." Grout includes two species, *M. ligulata* and *M. latifolia*. No sporophytes have been observed in North America. Only in Himalaya and in Japan is *M. ligulata* found fruiting.

Merceya ligulata was first described from Europe, in the eastern Pyrenees, by Richard Spruce (1849, p. 490), as *Encalypta? ligulata*. In 1851 Mueller referred it tentatively to *Zygodon*, and in 1869 Mitten transferred it to *Weisia*. It was not until 1876 that Schimper recognized it as belonging to a new genus, naming it for "A. de Mercey, florae bryologicae byerensis et pyrenaicae scrutatori acutissimo," basing it on the only species known until that time, *M. ligulata* (Spruce) Schimp. The habitat as given by Spruce is "in rupibus humidis praesertim ophiticis, locis Labassère, Superbagnères et Gorge de Cauterets."

In the second edition of Engler & Prantl, *Die natürlichen Pflanzenfamilien*, Brotherus (1927, p. 247) attributes seven species to *Merceya*, including *M. latifolia* Kindb. from western North America and five others from the Caucasus, Java, and South America. In a taxonomic revision of the genus, Noguchi (1956) reduced *Merceyopsis* Dix. to a synonym of *Merceya*, and so, on this view,

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the subfamily Merceyoideae Broth. of the Pottiaceae consists of a single genus, *Merceya,* with four species, distributed as follows:

M. ligulata (Spruce) Schimp. Europe, Azores, Caucasus, Asia Minor, Himalaya, China (Yunnan), Java, Japan, Formosa, U.S.A. (Arizona, Tennessee), Guatemala, Ecuador.

M. gedeana (Lac.) Nog. Himalaya, Philippines, Japan, Formosa, Korea, Bolivia.

M. difficilis Herz. & Thér. Peru.

M. latifolia Kindb. British Columbia, California, Utah, Colorado, and Montana.

The first report of *Merceya* in North America was made by E. B. Bartram (1924, p. 47-48) under the name *Scopelophila ligulata* Spruce. Bartram discovered it in February 1923 on damp shaded ledges in the Patagonia Mts., Santa Cruz Co., Arizona. Another collection by Mr. Bartram in the same region one year later, showed the mosses to be "abundant on wet or damp shaded ledges in narrow ravines throughout this range of mountains at elevations of about 1500 meters." He noted later (1927, p. 49) that his collection had been distributed in 1925 as var. *bartramii* E. Bauer.

The second discovery of *M. ligulata* was made in the southern Appalachian Mts. by Baur and Fulford (1934, p. 55) along the Alum Cave Trail near Alum Cave on Mt. LeConte in the Great Smoky Mts. at an altitude of about 5000 ft., Sevier Co., Tennessee, in 1933. Sharp (1936, p. 52) commented that the "distribution of this species is quite curious: Pyrenees, Salzburg, Arizona, and Sevier Co., Tenn." He presented later (1938, p. 143, map 3) a map showing the extremely limited distribution of *M. ligulata* in the United States. This species is mentioned again the following year by the same author (1939, p. 267) and in an article (1941, p. 67) on certain tropical and subtropical bryophytes occurring in Europe and in the Southern Appalachian region of eastern United States.

In a study of Tortulaceae in Tennessee, S. M. Wingo (1936, p. 37) cites *M. ligulata* from Sevier Co., Tennessee, and refers to Bartram's report from Arizona.

The only report of *M. ligulata* from Mexico is that of Bartram and Richards (1941, p. 61); Richards made a collection from a moist rock ledge in a canyon 26 miles southwest of Cumpas, Sonora. Perhaps through an oversight this Mexican reference is not included by Noguchi.

In 1947 Haring reported as var. *bartramii* another collection of *M. ligulata* from Arizona, at altitudes of 2400 to 4000 feet in Santa Cruz Co.

To the few American localities of this extremely local species we can now add northern Illinois: La Salle Co., on sandstone wall of canyon, Matthiessen State Park, July 17, 1952, *V. H. Chase* 12810 (ILL, CAN). The specimens were identified by Dr. H. Crum of the National Museum of Canada.

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BRYOPHYTES OF SOUTHWEST MISSOURI. IV. ADDITIONS TO THE FLORA

PAUL L. REDFEARN, JR.[1]

The following list includes species which have been collected by Mr. Robert R. Ireland, Jr., of the Smithsonian Institution and myself and are new state records or verifications of earlier records for which distributional data are lacking. Voucher specimens have been deposited, whenever possible, with the herbaria cited with each collection (abbreviations as listed in the "Index Herbariorum"). I should like to express my thanks to the various authorities who have examined or determined many of the following collections and to Mr. Ireland for permission to include his collections in this paper.

Riccia sullivantii Aust. On soil banks of creeks, Cedar Co., *Ireland* 3261, 3288, 3423 (US, det. by R. L. McGregor).

Solenostoma crenuliformis (Aust.) St. Mixed with *Scapania* in crevices of shaded sandstone, Dade Co., 7008.

Fissidens garberi Lesq. & James. On sandstone along creek, Cedar Co., *Ireland* 3500 (US, det. by H. Crum).

Fissidens ravenelii Sull. Crevices of sandstone, Dade Co., 6471 (det. by H. Crum and R. A. Pursell).

Archidium ohioense Schimp. Exposed sandy soil, Dade Co., 6987 (examined by H. Crum).

Trematodon longicollis Mx. Sandy creek bank, Cedar Co., *Ireland* 3294 (US).

Polytrichum commune var. *perigoniale* (Mx.) BSG. On soil, Cedar, *Ireland* 3459 (US) and Dade, 7007 (US) Counties.

Didymodon rigidulus Hedw. On limestone outcrops, Roaring River State Park, Barry Co., *Ireland* 3520 (US, det. by H. Crum).

Grimmia pulvinata (Hedw.) Sm. Frequent on exposed sandstone, Cedar, *Ireland* 3509 (US, det. by H. Crum), 6850, Dade, 6475, 7011, 7472, 7480, Polk, 6236 (COLO, det. by Geneva Sayre), Vernon, 6099 (US, FSU, det. by H. Crum), and St. Clair, 6764 (US, UT) Counties.

Ephemerum spinulosum Schimp. On soil along creek, Cedar Co., *Ireland* 3273 (US, det. by H. Crum).

Orthotrichum diaphanum Brid. Mixed with *O. pusillum* and *Frullania eboracensis* on bark of oak, Phelps Co., 7177 (examined by H. Crum).

Pohlia annotina var. *decipiens* Loeske. Sandy soil of dry creek bed, Cedar Co., *Ireland* 3435 (US).

Anomobryum filiforme (Dicks.) Solms. On sandstone, Cedar Co., *Ireland* 3462 (US, det. by H. Crum).

Mnium orthorhynchum Brid. On shaded moist limestone, Douglas Co., 7800 (examined by A. LeRoy Andrews).

Rhytidium rugosum (Hedw.) Kindb. Mixed with *Dicranum scoparium*

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on high bluffs above Jacks Fork River near Jam-Up Cave, Shannon Co., 6784 (US, UT, FSU, COLO).

Hypnum reptile Mx. On decaying wood, Hickory Co., 7061 (US, FSU, examined by H. S. Conard).

Isopterygyrium elegans (Hook.) Lindb. On shaded sandstone, Dade Co., 6990 (examined by H. Crum).

Plagiothecium sylvaticum (Brid.) BSG. On sandstone. Cedar Co., *Ireland* 3438 (US, det. by H. Crum).

Leskea arenicola Best. On decaying wood, Barton Co., 6525 (US, det. by H. S. Conard).

Cryphaea glomerata Schimp. On trunks of oak and maple, Barry, *Ireland* 3548 and 3577 (US) and Carter, *Ireland* 3235 (US) Counties.

Fontinalis disticha Hook. & Wils. Attached to rocks in intermittent creek, Phelps Co., 7186 (US, FSU, DPU, det. by Winona Welch).

REVIEWS

KARL VON KEISSLER: "Usneaceae." Dr. L. Rabenhorst's *Kryptogamen-Flora von Deutschland, Österreich und der Schweiz.* Band 9. Die Flechten. 5. Abteilung, 4. Teil. Lieferung 5. Pages i-xi [introduction and table of contents for the entire work] + 641-755. 19 plates. Akademische Verlagsgesellschaft Geest & Portig K.-G., Leipzig. 1960. DM. 19.50.—In the last part of the "Usneaceae," Dr. Keissler treats 12 remaining species of *Usnea, Thamnolia vermicularis, Siphula ceratites,* and, in the usual catch-all *"Natchtrag,"* a few taxa missed along the way.

The treatment of species conforms to the style which I have already described for the other parts. But in *Thamnolia*—traditionally monotypic but divided into two chemical species by Asahina—the author really deals with chemical variation in the lichens for the first time. Now there are certain arguments that can be used against interpreting chemical differences in morphologically indistinguishable lichens as criteria for species. For example, here in *Thamnolia,* the two species recognized by Asahina, *T. vermicularis* (Sw.) Ach. and *T. subvermicularis* Asahina, are characterized by substances that are chemically very similar. Moreover, these chemical species may grow side by side on more than one continent. Yet Keissler does not seize upon these points and develop them as one would expect him to. In fact it would be hard to find a better example than *Thamnolia* to harass the proponents of chemical species in lichens with. But Keissler simply seems offended that anyone would think of establishing species upon chemical grounds. In an attempt to prove Asahina wrong, he points out that color changes in old *Thamnolia* specimens, which Asahina had previously commented upon, are not constantly associated with specific thallus spot tests. But just as this is true it is also irrelevant since in the end Asahina did not use thallus color differences upon ageing but rather lichen chemistry itself in recognizing a second species. After going through the 16 pages that Keissler devotes to his "monotypic" *Thamnolia,* one should turn to at least the English part of Masami Sato's recent study of "two species" of the same genus (Misc. Bryol. & Lichenol. No. 22: 1-6. 1959). Even if the reader is still uncertain of whether there are two Thamnolias or only one, he will have gotten a more precise idea of the range and nature of the chemical variation in the genus from Sato.

This issue ends with an exhaustive index of the taxa treated in the whole

series and 19 plates of photographs most of which will not help in identifying specimens. But it would be unfair to complain of poor illustrations of members of the Usneaceae, a family of beautiful but notoriously unphotogenic subjects.—W. L. CULBERSON.

EILEEN M. BOLTON: *Lichens for Vegetable Dyeing*. 63 pp. 5 colored plates. Charles T. Branford Co., Newton Centre 59, Mass. 1960. $3.00.—This book is a practical guide for the preparation of textile dyes from lichens. Lichens are among the oldest sources of dyes (going back to Phoenician times) and even rather recently a knowledge of which lichens give good colors was relatively commonplace. But today synthetic colors are commercially more practical, and the subtle art of natural dyeing is being forgotten. Fortunately, Eileen Bolton reminds us that on the modest scale encountered by the hand-weaver, the preparation and use of natural dyes can be fun and that the lichens are a rich source of colors.

After a short historical review and discussion of some botanically important aspects of the lichens, 14 common species of dye-lichens are described and illustrated in colored plates of pleasantly stylized paintings by the author. The name, common synonyms, and the British vernacular names are given for each species. Habitats are described and other information is provided to help the collector in his search for dye-lichens. Finally the methods yielding dyes from lichens with ammonia or boiling water are explained in detail. There is even an original recipe by which Miss Bolton induced *Xanthoria parietina* to yield a remarkable pink dye which turns blue in sunlight—a rare color all together among the lichen pigments.

A wide variety of colors can be obtained from lichens. Many of what Miss Bolton calls her "boiling water lichens," the best source of yellows and browns, contain the yellow pigment usnic acid. Other lichens contain the brightly colored anthraquinones and, if these substances are present in sufficient quantity in the lichen, the thallus is pigmented. But the most important lichen dye of all is orchil which produces many shades of red and purple. Orchil itself is actually formed from colorless materials in certain lichens. As Miss Bolton points out, only lichens containing particular lichen acids—such as lecanoric, gyrophoric, or evernic acids—will yield orchil. A few other lichen acids should theoretically give this dye, but the ones she mentions are by far the most common. Although Miss Bolton confines her attention to the practical aspects of dyeing, one might wonder why lichens containing only colorless compounds can yield brilliant orchil dyes. When an appropriate lichen is steeped in ammonia, any of the acids named above will decompose to one and the same colorless substance: orcinol. As early as 1829 it was known that, upon treatment with ammonia, synthetic orcinol yields a colored material very similar to the natural dye. Rather recently Dr. Hans Musso of the University of Göttingen began research on pigments derived from orcinol and has now shown that orchil is really a mixture of several different, colored compounds. A number of pigments have been separated by paper chromatography and, in 1957, the chemical structure of one of the components of this ancient dye was finally determined. Because the orchil dyes are so very complex, it is not surprising that different hues are produced by even slight variations in the procedure for extracting the active principles.

Eileen Bolton's little book is well written with careful attention to botanical accuracy. Although intended as a guide for the hand-weaver, the readable text and the pretty plates will make it an enjoyable addition to the library of many cryptogamic botanists and naturalists.—CHICITA F. CULBERSON.

RECENT LITERATURE ON HEPATICS

MARGARET FULFORD[1]

ABEL, W. O. Untersuchungen über die Mutagene Wirkung von Maleinsäurehydrazid an *Sphaerocarpus donnellii*. Chromosoma 11: 322-334. 10 fig. 4 tab. 1960.

AMAKAWA, T. Notes on Japanese Hepaticae (4). Jour. Jap. Bot. 32: 165-169. 1 fig. 1957. [New: *Nardia grandistipula* var. *biloba* (Horik.) c. n., *N. geoscyphoides* sp. n., *N. unispiralis* sp. n.]

———. Notes on Japanese Hepaticae (5). *Ibid.* 32: 215-219. 3 fig. 1957. [New: *Plectocolea ariadne* var. *brunnea* (Hatt.) c. n., *P. biloba* Hatt. sp. n., *P. horikawana* sp. n.]

———. Notes on Japanese Hepaticae (8). *Ibid.* 33: 338-343. 2 fig. 1958. [New: *Calypogeia tsukushiensis* sp. n., *Plectocolea emarginata* sp. n., *P. hattoriana* sp. n.]

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———. Family Jungermanniaceae of Japan. II. Jour. Hattori Bot. Lab. 22: 1-90. 41 fig. 8 maps. 5 tab. 1960. [English; new: subg. PLECTOCOLEA (Mitt.) c.n., *Jungermannia* (Plectocolea) *erecta* (Amak.) c.n., *J.* (Plectocolea) *hattorii* Amak. nom. n., *J.* (Plectocolea) *unispiris* (Amak.) c.n., *J.* (Plectocolea) *flagellata* (Hatt.) c.n., *J.* (Plectocolea) *hattoriana* (Amak.) c.n., *J.* (Plectocolea) *subelliptica* (Lindb.) c.n. & var. *nana* var. n., *J.* (Plectocolea) *rupicola* sp. n., *J.* (Plectocolea) *kyushuensis* nom. n., *J.* (Plectocolea) *plagiochiloides* sp. n., *J.* (Plectocolea) *harana* (Amak.) c.n., *J.* (Plectocolea) *otiana* (Hatt.) c.n., *J.* (Plectocolea) *magna* (Amak.) c.n., *J.* (Plectocolea) *infusca* var. *ovicalyx* (Steph.) c.n. & var. *ovalifolia* (Amak.) c.n., *J.* (Plectocolea) *horikawana* (Amak.) c.n., *J.* (Plectocolea) *tsukushiensis* (Amak.) c.n., *J.* (Plectocolea) *rubipunctata* (Hatt.) c.n., Sect. SCHIZOPHYLLON sect. n., *J.* (Plectocolea) *cephalozioides* nom. n., *J.* (Plectocolea) *japonica* nom. n., *J.* (Luridae) *cordifolia* ssp. *exsertifolia* (Steph.) c.n., *J.* (Luridae) *kuwaharae* sp. n., Subg. SOLENOSTOMA (Mitt.) c.n., sect. PROTOSOLENOSTOMA, sect. n., *J.* (Solenostoma) *koreana* (Steph.) c.n., *J.* (Solenostoma) *pyriflora* var. *minutissima* (Amak.) c.n. & var. *major* (Hatt.) c.n., *J.* (Solenostoma) *handelii* (Schiffn.) c.n., *J.* (Solenostoma) *rishiriensis* (Amak.) c.n., Sect. DESMORHIZA sect. n., *J.* (Solenostoma) *clavellata* (Mitt.) c.n., *J.* (Jungermannia) *lanceolata* ssp. *stephanii* ssp. n.]

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P. subrigidula nom. n., *Pedinophyllum truncatum* (Steph.) c.n., *P. truncatum* var. *jungermannioides* (Steph.) c.n., *Plagiochila ovalifolia* fo. *magna* (Inoue) fo. n., *Plagiochilon hattorii* (Inoue) c.n.]

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RECENT LITERATURE ON MOSSES

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RECENT LITERATURE ON LICHENS—37[1]

WILLIAM L. CULBERSON[2]

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ALMBORN, O. Lichenes Africani. Fasc. II (Nos. 26-50). 10 pp. Lund. 1960. [Labels for this exsiccat.]

ASAHINA, Y. Lichenologische Notizen (§165-169). Jour. Jap. Bot. 35(10): 289-295. 6 fig. 1960. [New: *Stereocaulon japonicum* v. *subfastigiatum* n. v., v. *commixtum* n. v., subsp. *etigoense* n. subsp.; *S. pseudodepreaultii* n. sp.; *S. exile* n. sp.; *S. verruculigerum* v. *formosanum* n. v.]

[BARASHKOVA, E. A.] [The effect of gibberellic acid on the growth of the reindeer moss *Cladonia rangiferina* (L.) Web.] [Bot. Zhur., Akad. Nauk SSSR] 45(5): 748-750. 1 tab. 1960. [In Russian.]

[BARKHALOV, SH. O.] [Distribution of lichens in the Kusary district.] [Doklady Akad. Nauk Azerbaidzhaiskoi SSR] 16(3): 285-288. 1960. [Many spp. In Russian, summary in White Russian.]

[1] The names of new taxa from the Americas are marked with an asterisk (*).

[2] Dept. of Botany, Duke University, Durham, N. C.

[———.] [Lichens of the Kusary district of Azerbaydzhan.] [Trudy Inst. Bot. Akad. Nauk Azerbaidzhaiskoi SSR] *22*: 39-64. 1960. [144 spp. In White Russian, summary in Russian.]

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CULBERSON, W. L. The discovery of the lichen *Parmeliopsis placorodia* in western North America. Madroño 16(1): 31. 1961.

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KERSHAW, K. A. The genus *Stereocaulon* Schreb. in the British Isles. *Ibid.* 1(4) : 184-203. 16 fig. 1960. [Key to 18 taxa.]

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WETMORE, C. M. The lichen genus *Nephroma* in North and Middle America. Publ. of the Mus., Michigan State Univ., Biol. ser. 1(11) : 369-452. 13 fig. 2 pl. 1960. [Recognition of 8 spp. Key. New: *N. helveticum* v. *sipeanum* (Gyel.) n.c.]

RECENT LITERATURE ON LICHENS—38[1]

WILLIAM L. CULBERSON[2]

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AWASTHI, D. D. Contributions to the lichen flora of India and Nepal. I. The genus *Physcia* (Ach.) Vain. Jour. Indian Bot. Soc. 39(1): 1-21. 12 fig. 1 pl. 1960. [22 spp. Key. New: *Physcia aspera* v. *alutacea* Magn. n. v., *P. picta* v. *endochroma* Magn. & Awasthi n. v.]

[BARASHKOVA, E. A.] [Some peculiarities of growth of the fodder lichen *Cladonia rangiferina* (L.) Web. under conditions of the Murmansk region.][3] [Bot. Zhurnal] [Moscow] 46(3): 410-414. 5 fig. 2 tab. 1961.

BOLTON, EILEEN M. Lichens for Vegetable Dyeing. 63 pp. 5 pl. and a frontispiece in color. Charles T. Branford Co. Newton Centre 59, Massachusetts. 1960. Price: $3.00. [Practical recipes for dyeing media prepared from lichens. Printed in Italy, issued simultaneously by an English publisher. Reviewed in this issue of *The Bryologist*.]

BOULY DE LESDAIN, [M.] *Lecanora flandrica* n. sp. B. de Lesd. Lichen végétant sur des tablettes en ciment placées pour l'écoulement de la pluie à la base des fenêtres d'une maison. Rev. Bryol. et Lichénol. 29(3-4): 277-278. (1960) 1961.

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[1] The names of new taxa from the Americas are marked with an asterisk (*).

[2] Dept. of Botany, Duke University, Durham, N. C.

[3] Names and title transliterated and translated respectively from the Russian.

evidence in support of the suggestion that depsidones are formed *in vivo* from depsides."]

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DAVIDSON, T. A. & A. I. SCOTT. Total synthesis of picrolichenic acid. Proc. Chem. Soc. [London] 1960: 390-393. 1960. [The substance occurs naturally in *Pertusaria amara* (Ach.) Nyl.]

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lata (Duvign.) n. c.; *Omphalodium stictellum* (Mass.) n. c., *O. phalacrum* (Hue) n. c., *O. hypoleium* (Nyl.) n. c. with v. *tenuifidum* (Nyl.) n. c., *O. ceranoides* (Lam.) n. c., *O. pachythallum* (Spreng.) n. c., *O. mazoense* n. sp., *O. umbilicatum* (Del.) n. c.]

[Evdokimova, T. I.] [Soil formation processes on metamorphic rocks of Karelia.][3] [Pochvovedenie] 1957(9): 60-69. 1957. [6 lichens. "In the nitrogen balance of these soils a very important role belongs to lichens, which are carriers of a specific group of oligonitrophile micro-organisms." —English summary.]

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———. Eine dornbewohnende Flechtengesellschaft der zentralchilenischen Sukkulentenformationen mit kennzeichnender *Chrysothrix noli-tangere* Mont. Ber. Deutsch. Bot. Gesell. 73(10): 449-462. 4 fig. 3 tab. 1960. [33 lichens.]

———. Die Durchlässigheitseigenschaften der Protoplasten von Phycobionten aus *Cladonia furcata* (Huds.) Schrad. Die Naturwissenschaften 47(17): 405-406. 1 fig. 1960. [The permeability of the protoplasm of lichen algae may be regulated by lichen substances produced by the fungal component.]

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———. A zsombói láperdö zuzmóflórája. [Flora lichenologica silvae "Zsombói Erdö."] A Móra Ferenc Múz. Évkönyve, Évi Köteteeöl 1958-59: 251-258. 2 tab. (1958-59) 1960. [42 spp. Latin summary.]

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MATTICK, F. History and literature of lichenology. Proc. IX Internatl. Bot. Congr. [Montreal]. Vol. 2: 255-256. 1959. [Abstract.]

MURRAY, J. Studies of New Zealand lichens. Part I—The Coniocarpineae. Trans. Roy. Soc. New Zealand 88(2): 177-195. Pl. 12-13. 1960. [New: *Calicium abietinum* v. *australe* n. v.; *C. subnigricans* n. sp.; *C.* subgen. CRASSISTIPITUM n. subgen. including *C. martinii* n. sp.; *Coniocybe otagoënse* n. sp.; *Pyrgillus crassus* n. sp.; *Sphaerophorus cuneatus* (Stirt.) n. c.; *S. melanocarpus* v. *melanocarpus* f. *ramosissimus* n. f., *S. m.* v. *australis* (Laur.) n. c. with f. *angustior* (Reinke) n. c., f. *delicatus* n. f., f. *insignis* (Laur.) n. c., f. *palmatus* n. f., f. *proliferus* (Wilson) n. c., f. *subteres* (Zahlbr.) n. c., f. *vividulus* (Colenso) n. c., *S. m.* v. *scrobiculatus* (Bab.) n. c. with f. *macrophyllus* (Zahlbr.) n. c.; *Sphaerophorus tener* f. *globosoides* n. f.]

———. Studies of New Zealand lichens. Part II—The Teloschistaceae. *Ibid.* 88(2): 197-210. 1960. [New: *Xanthoria parietina* v. *incavata* (Stirt.) n. c.; *Teloschistes fasciculatus* v. *nodulosus* n. v., *T. flavicans* v. *compressus* n. v., *T. spinosus* (Hook. f. & Tayl.) n. c., *T. xanthorioides* n. sp.]

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———. *Verrucaria polonica* n. sp., nowy gatunek porostu z południowej Polski—*Verrucaria polonica* n. sp., lichen de Polonia meridionali. *Ibid.* 5(1): 155-163. 3 fig. 1959.

[OKSNER, A. M.] [Summary of the investigations of cryptogamic plants in the Ukraine over 40 years (1917-1957).][4] [Ukraïnskii Bot. Zhurn.] 14(3): 12-19. 1957. [Lichens included.]

[———.] [C. Linnaeus. On the 250th anniversary of his birth.][4] *Ibid.* 14(3): 91-101. 1 portrait. 1957. [Includes a discussion of Linnaeus' treatment of lichens.]

[———.] [A new species of lichen *Leptotrema lithophila* sp. n. in the flora of the USSR.][4] *Ibid.* 17(4): 67-74. 1 fig. 1960. [English summary.]

[——— & E. G. Kopachevska.] [On *Roccella fucoides* (Neck.) Vain. found in the Crimea.][4] *Ibid.* 16(1): 101-105. 1959. [English summary.]

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[4] Names and title transliterated and translated respectively from the Ukrainian.

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———. Lichenes Selecti Exsiccati, Editi ab Instituto Botanico Universitatis Agriculturae et Silviculturae, Brno. Fasc. I (no. 1-25). 7 pp. 1960. [Labels for specimens. New: *Lecidea umboniza* Nádv. n. sp., *Biatorella ochrophora* v. *planiuscula* n. v.]

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WADE, A. E. Glamorgan botanical notes. Trans. Cardiff Natural. Soc. 87: 27. (1957-58)1960. [12 lichens.]

———. The lichens of Dale, Pembrokeshire. Nat. in Wales 6: 49-55. 1960. [About 100 spp.]

WEBER, W. A. Lichenes Exsiccati. Distributed by the University of Colorado. Boulder, Colorado, U.S.A. Fasc. I (no. 1-40). 15 unnumbered pp. 1961. [Labels. New: *Lasallia pustulata* subsp. *papulosa* (Ach.) n. c., *Lecanora arizonica* (Tuck.) n. c.]

WERNER, R.-G. Contribution à la flore cryptogamique du Maroc. Fascicule XXII (Anti-Atlas fin). Bull. Soc. Hist. Nat. Afrique du Nord 50(3-4): 104-113. 1959. [40 spp. New: *Anapyrenium subinsulare* n. sp.; *Lecanora* (Aspicilia) *antiatlantea* n. sp., *L.* (Eulecanora) *subglabrata* n. sp.]

WYNDHAM, J. Trouble with Lichen. 160 pp. Balantine Books. New York. 1960. Price: $0.35. [Amusing and entertaining science fiction novel brimming with fractured lichenology.]

NEWS AND NOTES

Word was received in June that Mrs. W. KEATING JOHNSON recently died. Dr. OLAF HAGERUP died in Copenhagen March 22.

RUDOLF M. SCHUSTER left on July 1 for New Zealand, where he has a Fulbright Exchange Professorship at the University of Otago, Dunedin.

HANSFORD T. SHACKLETTE, formerly of Georgetown College in Kentucky, has moved to Denver where he has accepted a full-time research position with the U. S. Geological Survey.

CHARLES D. BIRD has been granted a renewal of his National Research Council fellowship for study of the mosses of the prairie provinces of Canada. Plans for this summer include extensive collecting in Alberta, Saskatchewan, and Manitoba.

In my paper on "Substrate relationships of some bryophyte communities, etc." in the last issue of *The Bryologist*, I stated that "this report of *Scapania undulata* may be the first indication that any species of leafy liverwort is a facultative halophyte." Just recently, on reading more carefully the article by W. Meijer ("Bryologische brief uit Noord-Borneo," Buxbaumia 14: 15-18. 1960), I find this statement, "Op zandig terrein aan de binnekant van de mangrove, min of meer nog onder invloed van het zoute water, soms tegen krabbenheuvels vindt men vaak het levermosje *Lepidozia mamillosa*, indertijd door Schiffner beschreven van eilanden in de Z. W.-Pacific. Dat is het enige halophiele levermos in Noord-Borneo."—H. T. SHACKLETTE.

Prices of back issues of the *Journal of the Hattori Botanical Laboratory* have recently been revised, as follows: no. 3, $1.20; no. 4, $1.10; no. 5, $1.20; no. 6, $0.80; nos. 7-10, $1.10; nos. 11-12, $1.30; no. 13, $1.00; nos. 14-15, $1.30; no. 16, $1.40; no. 17, $1.10; no. 18, $1.50; no. 19, $1.60; nos. 20-21, $3.00; no. 22, $3.40; no. 23, $2.40. Prices, quoted in American dollars, include postage.

ALBERT SCHATZ, chief of the microbiology division, Philadelphia

General Hospital, has been awarded a $4000 Dental Research Prize by the Soil and Health Foundation; Dr. Schatz is known for his proteolysis-chelation theory of dental caries and for research on streptomycin.

JOHN W. THOMSON left April 20 for an extensive tour of European herbaria in connection with the preparation of his manual of arctic American lichens. He expected to return August 17.

The following Sigma Xi grants were announced in September: $350 to HOWARD G. APPLEGATE (Southern Illinois University)—"The effects of steroid-type hormones on *Sphaerocarpus* spp. $400 to DHARANI DHAR AWASTHI (University of Colorado)—"Lichens, particularly Indian lichens." $400 to CLIFFORD M. WETMORE (Michigan State University)—"Migration rates of lichens in the Black Hills."

The Los Angeles County Museum has acquired the general lichen collection of ALBERT W. HERRE (13,750 packets), particularly rich in specimens of *Usnea* and material from the Pacific Coast states and the Hawaiian Islands. Dr. Herre has retained his large unnamed Philippine collection. He is currently working on Philippine Usneas and Stictaceae; when they are finished, he will take up the Graphidaceae. Dr. Herre celebrated his 93rd birthday on September 16; he is still actively at work in spite of a heart block suffered last March.

WINONA H. WELCH collected in Panama and the Canal Zone August 8-23, while a guest of Mr. and Mrs. T. F. Hotz and their daughter, Judith, in Balboa. On August 16 she presented an illustrated talk on plant collecting in Alaska to the Panama Canal Natural History Society.

THEODOR HERZOG, an honorary member of the society, died on March 6 at the age of 81. His herbarium and library was willed to the Friedrich Schiller University in Jena. (Requests for loans should be addressed to Dr. O. Schwarz, Institut für spezielle Botanik, Goetheallee 26, Jena.)

ROBERT ANDRÉ LÉOPOLD POTIER DE LA VARDE died on March 19 at the age of 83. His herbarium and a part of his library has been acquired by the Laboratoire de Cryptogamie, Muséum National d'Histoire Naturelle, Paris.

JERZY SZWEYKOWSKI, noted Polish hepaticologist, is at the University of California at Los Angeles, studying with Dr. Mildred Mathias new methods of experimental taxonomy, particularly as applied to the angiosperm genus *Gayophytum*. On return to Poland he will apply these methods to the study of hepatics. After leaving the U.S. in the spring or early summer of 1962, he plans to study at the Riksmuseum in Stockholm.

ELVA LAWTON has received an NSF grant for the preparation of an illustrated moss flora of the Pacific Northwest.

HOWARD CRUM is teaching a course in bryophytes at Carleton University, Ottawa, during the fall term.

C. E. B. BONNER (Jardin Botanique, Genève) is spending a year at Miami University, Oxford, Ohio, working with H. A. Miller.

WINONA H. WELCH was made an honorary member of the American Bryological Society at the annual meeting at Purdue University.

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Beginning January 1, 1939, this Exchange has been operated under the same rules as The Moss Exchange. Privileges are available only to members of the American Bryological Society who have paid annual dues of 25c to MR. HARRY WILLIAMS, Millbrook, Ont., Canada. Only fully determined specimens in packets with complete data will be accepted. It is suggested that there be at least five packets of each species with an extra which will be forwarded to the Curator of Hepatics for the American Bryological Society Hepatic Herbarium. All material for determination should be sent to the Curator of Hepatics, DR. MARGARET FULFORD, Department of Botany, University of Cincinnati, Cincinnati, Ohio.

THE MOSS EXCHANGE

As announced in THE BRYOLOGIST **38**: 100, Sept.-Oct., 1935, there is now an exchange for mosses. This exchange is available to members of the American Bryological Society upon payment of annual dues of 25c to DR. RONALD A. PURSELL, School of Forestry, University of Pennsylvania, Mont Alto Branch, Mont Alto, Pa. Only fully identified specimens in packets with complete data on them should be sent in. It is suggested that there be five or more packets of each species.

These two exchanges offer an excellent opportunity for A.B.S. members to build up their own herbaria of choice, well-labelled specimens.